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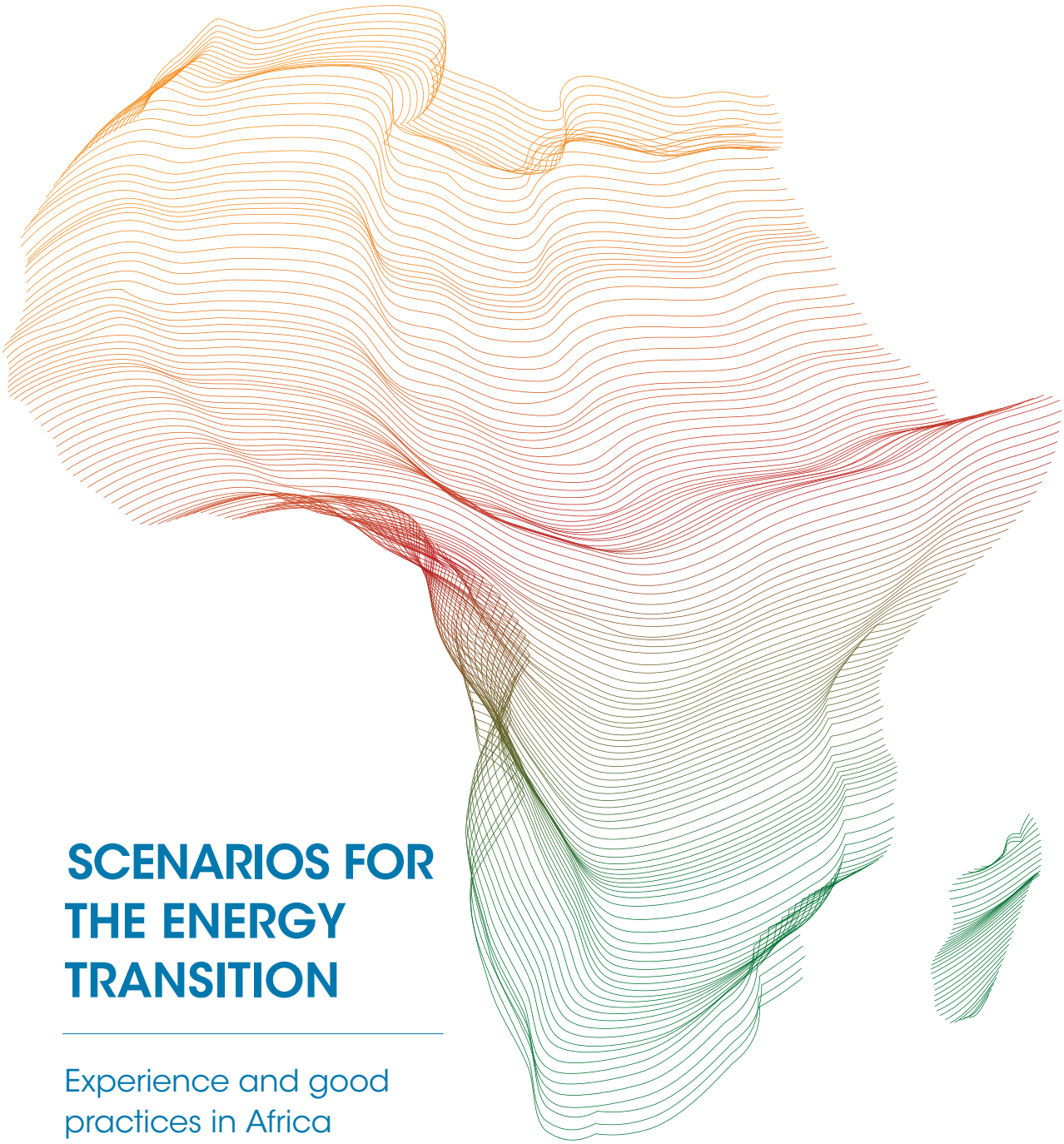

SCENARIOS FOR THE ENERGY TRANSITION

Experience and good practices in Africa

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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. www.irena.org

Keywords

Energy scenarios, long-term scenarios, energy planning, Africa, scenarios modelling

Disclaimer

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This report synthesises findings from the webinar series "Long-term energy scenarios (LTES) for Developing National Clean Energy Transition Plans in Africa". Participants from each participating country revised the content and provided useful material. They are:

Speakers from the governments:
- Grace Njeru: Kenya Electricity and Transmission Company
- Hala Ramadan: New & Renewable Energy Authority of Egypt
- Ali Ahmed Ali: Ministry of Electricity and Renewable Energy of Egypt
- Nolwazi Khumalo: Ministry of Natural Resources and Energy of Eswatini
- Eli Jidere Bala: Energy Commission of Nigeria
- Fatiha Machkori: Ministry of Energy, Mines and Environment for Sustainable Development of Morocco
- Hassen Elagrebi: National Agency of Energy of Tunisia
- Oagile Johannes Setlhare: Department of Energy of Botswana
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Speakers from technical institutions:
- Clinton Carter-Brown: Council for Scientific and Industrial Research of South Africa
- Patrice Manirakiza: Eastern Africa Power Pool
- Bernard Hessou: West African Power Pool
- Emmanuel Bué: Mediterranean Transmission System Operators

Speakers from partner institutions:
- Christopher Gross, GET.transform
- Linus Mofar and Mekalia Paulos, UNECA
- Moussa Adama, AfDB
- Bothwell Batidzirai and Simbini Tichakunda, AUDA-NEPAD
- Peter Kinuthia, AUC

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ABBREVIATIONS

AfDB	African Development Bank
AFREC	African Energy Commission
AU	African Union
AUDA	African Union Development Agency
CCC	collaboration, contribution and control
CMP	African Continental Power System Master Plan
CO_2	carbon dioxide
COMESA	Common Market for Eastern and Southern Africa
CSIR	Council of Scientific and Industrial Research (South Africa)
CSP	concentrating solar power
EAC	East African Community
EAPP	Eastern African Power Pool
ECA	Initiative of the Economic Commission for Africa
ECOWAS	Economic Community of West African States
EU	European Union
EX-ACT	EX-Ante Carbon-balance Tool
GDP	gross domestic product
GHG	greenhouse gas
IAEA	International Atomic Energy Agency
ICT	information and communications technology
INEP	Integrated National Energy Plan (Kenya)
IPM	Integrated Panning Model
IPSMP	Integrated Power Sector Master Plan (Ghana)
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan (South Africa)
IRRP	Integrated Resource and Resilience Planning
ISES	Integrated Sustainable Energy Strategy (Egypt)

KEPSA	Kenya Private Sector Alliance
KETRACO	Kenya Electricity Transmission Company
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power and Lighting Company
LCPDP	Least Cost Power Development Plan (Kenya)
LEAP	Low Emissions Analysis Platform
LTES	long-term energy scenarios
MDAs	ministries, departments and agencies
Med-TSO	Mediterranean Transmission System Operator
MNDP	Mediterranean Network Development Plan
MRV	measurement, reporting and verification
NDC	Nationally Determined Contribution
NECAL2050	Nigeria 2050 Calculator
NEMP	National Energy Master Plan (Nigeria)
NEP	National Energy Policy (Botswana)
NEPAD	New Partnership for Africa's Development
PPTC	Power Planning Technical Committee (Ghana)
PV	photovoltaic
REC	Regional Economic Community
RMC	regional member country
SADC	Southern African Development Community
SAEP	South African Education Project
SDG	Sustainable Development Goal
SE4All	Sustainable Energy for All
SNBC	National Low-Carbon Strategy (Tunisia)
SPLAT	system planning test
TC-ESS	Technical Committee Economic Studies and Scenarios (Med-TSO)
TC-P	Technical Committee Planning (Med-TSO)
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
WAPP	West African Power Pool

INTRODUCTION

ABOUT THE WEBINAR SERIES

This report summarises the presentations and discussions held at the webinar series "Long-term energy scenarios (LTES) for Developing National Energy Transition Plans in Africa" (IRENA, 2022a), which took place between 29 November 2021 and 13 January 2022.

The webinar series was hosted by the International Renewable Energy Agency (IRENA) in collaboration with regional implementation partners including United Nations Economic Commission for Africa (UNECA), GET.transform, African Union Development Agency (AUDA-NEPAD), the African Development Bank (AfDB), the Ministry of Energy of Kenya and the African Union Commission. This event was part of the activities conducted by IRENA's LTES Network.

The webinar series provided a platform to exchange knowledge and good practices in the development and use of LTES by the government sector for planning a clean energy transition in Africa. Nine countries participated in the series: Botswana, Egypt, Eswatini, Ghana, Kenya, Morocco, Nigeria, South Africa (represented by the Council of Scientific and Industrial Research) and Tunisia. To complement the national presentations, the Mediterranean Transmission System Operator (Med-TSO), West African Power Pool (WAPP) and Eastern African Power Pool (EAPP) contributed, exhibiting their experiences at regional level. The webinars explore how these African countries are elaborating LTES to face the challenges associated with energy production, transport/transmission, distribution and consumption, considering that the future energy system tends to be more digitalised, decentralised and decarbonised.

OBJECTIVES

The webinar's focus was on the governance structure around the development and use of LTES to plan the energy transition and institutional efforts to enhance them. This includes national efforts to improve the scenarios' elaboration process and use, considering the complexity surrounding the clean energy transition. The series was not meant to focus on displaying quantitative scenario results or specific energy policies, targets or goals for the expansion of new infrastructure. The LTES-Africa webinar series was based on three pillars (see Figure 1) that were used as a guide for the presentations and during the discussion sessions. The summary of each presentation is displayed below and is organised by country, in alphabetical order and according to the three pillars.

Figure 1 Main topics addressed in the webinar series, Long-term energy scenarios (LTES) for developing national energy transition plans in Africa

01 STRENGTHENING SCENARIO DEVELOPMENT

Key question:
How can scenarios be developed to better account for potentially transformational changes?

Topic breakdown:

1.1 Establishing a strong governance structure
- Participatory processes
- Co-ordination among entities concerned with long-term energy scenarios

1.2 Expanding the boundaries of scenarios
- Scenarios for a clean and just energy transition
- Accounting for innovation in the energy sector

02 IMPROVING SCENARIO USE

Key question:
How can scenarios be better used for strategic decision making by governments and investors?

Topic breakdown:

2.1 Clarifying the purpose of scenario building
- Forecasting and backcasting
- Building consensus and raising ambition
- Conservative and exploratory scenarios

2.2 Transparent and effective communication
- Effective communication tools
- Transparent and publicly available information

03 IDENTIFYING CAPACITY BUILDING APPROACHES

Key question:
What approaches can enhance institutional capacity for scenario planning?

Topic breakdown:

3.1 Building the right type of scenario development and analysis capacity in government
- Insourcing scenario development capacity
- Outsourcing scenario modelling and development capacity

Source: IRENA (2021, 2022b).

ORGANISING INSTITUTIONS AND RELEVANT LTES ACTIVITIES

AFDB

The African Development Bank (AfDB) works in partnership with AUDA-NEPAD on the development of the African Continental Power System Master Plan (CMP). The objective of the AfDB is to stimulate sustainable economic development and social progress in its regional member countries (RMCs), thus contributing to poverty reduction. In June 2022, the AfDB published the "2nd Climate Change Action Plan (2016-2020)" (AfDB, 2022), which highlights the importance of investing in low-carbon development. It describes renewable energy technologies not only as commercially viable, but in many cases as the cost-effective option for electrification in Africa.

AU COMMISSION

The African Union (AU) is a continental body. The Department of Infrastructure and Energy of the AU is responsible for co-ordinating and promoting the development of the energy, transport, tourism, and information and communications technology (ICT) sectors in Africa. The department co-ordinates the harmonisation and promotion of sound policies, strategies and programmes for the development of the infrastructure and energy sectors at the continental level in support of social, economic and human development.

AUDA-NEPAD

The New Partnership for Africa's Development (NEPAD) is a socio-economic flagship programme of the African Union Development Agency (AUDA). Its mission is to assist African member states to strengthen capacity in key areas, such as food and nutrition, energy, water, infrastructure, ICT and the digital economy, natural resource governance, climate change, institutional and human capital development, and innovation. At present, AUDA-NEPAD leads the development of the African Continental Power System Master Plan (CMP).

GET.TRANSFORM

GET.transform is a technical partner of the LTES Network and supports communication efforts. GET.transform supports countries and regions on the African continent with regulatory advice to accelerate rural electrification and scale up investments in off-grid renewable energy solutions. Through framework development, systematic tools and regulatory instruments, training, and dedicated knowledge products, GET.transform helps to strengthen institutional processes to integrate energy and climate priorities.

IRENA

The goal of the International Renewable Energy Agency's (IRENA's) Long-term Energy Scenarios Network (LTES Network) is to provide a global platform to exchange knowledge and good practices in the use and development of model-based LTES to guide the clean energy transition. It aims to promote wider and more effective use of LTES in governments for energy and climate policy making. In 2020, IRENA published *Scenarios for the energy transition: Global experience and best practices* (IRENA, 2020), presenting a collection of more than 50 practices from more than 20 countries and technical organisations around the world. These practices are presented to improve the use and development of LTES and provide guidance towards a clean energy transition.

MINISTRY OF ENERGY OF KENYA

The government of Kenya, through the Ministry of Energy, is a member of the LTES Network. The Ministry of Energy of Kenya seeks to develop and implement policies that create an enabling environment for efficient operation and growth of Kenya's energy sector. The ministry sets strategic directions to facilitate sectoral growth while providing a long-term vision for all sector players.

UNECA

The United Nations Economic Commission for Africa (UNECA) is the regional commission of the United Nations for Africa that hosts the Energy Modelling Platform for Africa. Its mandate is to promote the economic and social development of its member states, foster intra-regional integration and promote international co-operation for Africa's development. In 2021, UNECA announced the creation of Team-Energy Africa, which aims to serve as a catalyst for transformative private sector investments in clean energy under the Sustainable Development Goal 7 (SDG7) Initiative of the Economic Commission for Africa (ECA) (UNECA, 2022).

MAIN REMARKS

Nine African countries that feature robust energy planning process shared their practices according to the framework established under the earlier activities of LTES work (Figure 1). Practices on the use of long-term energy scenarios (LTES) for energy planning by African countries presented during the webinar are summarised below.

1. STRENGTHENING SCENARIO DEVELOPMENT

Pillar 1.1 Establishing a strong governance structure

Comprehensive and up-to-date statistics and plans

- Egypt and Eswatini frequently update the input data and assumptions used in developing LTES.
- Continuous updating allows planning officials to track changes in demographics, account for technological maturity and integrate metrics related to economic growth, energy prices and more. Additionally, this results in shorter and more accurate consecutive planning cycles.
- All countries regularly update the energy plans with an interval of 3-5 years. Egypt and Nigeria have legislated such updates in their national planning framework.

Broad stakeholder participation in LTES development

- Eswatini, Ghana, Kenya, Morocco, Nigeria and Tunisia prioritise national and international collaboration with diverse entities during the development of their scenarios as well as during the drafting and review phases of their planning documents, to ensure participation from the initial stages.
- Botswana, Eswatini and Ghana have established strong coordination mechanism among LTES entities through inter-institutional committees to ensure accurate information sharing and a collaborative approach.
- Government institutions, the private sector, academia and other research institutions jointly participate in modelling scenarios and identifying attendant energy planning strategies. Broad participation builds consensus around scenarios and policy development among stakeholders with differing priorities, as is the case in Ghana, Tunisia and within the WAPP and Med-TSO.
- Morocco and Tunisia noted that solid governance structures empower the public to participate in national sustainable energy transitions.

Pillar 1.2 Expanding the boundaries of planning scenarios

Social and environmental aspects in energy planning scenarios

- Seven countries emphasised the importance of including social and environmental aspects in the development of energy plans and policies. Ghana, Morocco and Nigeria highlighted that they are raising the ambition of their environmental and social targets.

- Botswana and South Africa both integrated carbon-neutral scenarios and equity metrics in their scenarios. Other countries retain a focus on the consolidation and expansion of their power sector.

- Egypt prioritised least-cost and least-regret scenarios to support its efforts to expand energy security and access. Governments with comprehensive high-level planning at the national level have additionally moved to co-ordinate regional power sector development plans.

Ambitious renewable energy targets for their power systems

- Governments explored developmental challenges and opportunities related to the expansion of generation, transmission and distribution. The countries are assessing the viability of integrating solar photovoltaic (PV), wind and hydropower plants into their national energy infrastructures.

- Nigeria and South Africa are developing strategies for increasing the share of biogas, biofuels, concentrated solar power (CSP) and geothermal in their energy mix.

- Egypt, Eswatini and Ghana have adopted energy efficiency programmes such as electric mobility programmes and the promotion of appliances powered by electricity generated by the local agriculture sector.

2. IMPROVING SCENARIO USE

Pillar 2.1 Clarifying the purpose of scenario building

Using scenarios to inform investment and policy decisions

- Governments use scenario-building as a way to gather important information about when and how to invest in different parts of their national energy systems. In addition to the technical information obtained, this process helps identify key institutions to work with when making investment and policy decisions

- Eswatini, Ghana and Kenya use energy and power system optimisation and least-regret scenarios to inform network infrastructure investments and minimise risks

- Kenya, Morocco, Nigeria, and South Africa use scenarios to inform policymakers, the public (at local and national levels), and the private sector about options for increasing the deployment of renewables and decreasing reliance on fossil fuels.

Pillar 2.2 Transparent and effective communication

Transparency and continuous communication with the public

- Botswana and Egypt, set up workshops and government websites to communicate energy scenarios to the public.

- Government institutions in Ghana, Kenya and Morocco use diverse media, including virtual meetings, reports and presentations, to target stakeholders such as high-level private sector actors, utilities, academia, trade unions and other groups. Publicising scenario development and energy policy contributes to transparency and accountability by building trust around the energy planning process.

3. IDENTIFYING CAPACITY BUILDING APPROACHES

Pillar 3.1 Building the right type of scenario capacity in government

Strengthening capacity for mid- to long-term energy planning

- Countries have partnered with international organisations and the private sector to strengthen their capacity for energy planning for the mid- to long-term, which is approximately 10 to 15-plus years.

- Countries secure financial resources and technical assistance through international partnerships throughout their capacity-building process. International partners can, for example, support African countries in establishing local energy planning units.

- Kenya, EAPP, WAPP and Med-TSO have worked in close collaboration with consultants to ensure their skill sets are transferred to government institutions involved in developing LTES and setting energy policy.

The following country chapters contain an outline of key planning institutions, publications and practices. This is followed by a summary of good practices shared by the country. Depending on the topic addressed, they are categorised under the three main pillars highlighted in the introduction: **strengthening scenario development, improving scenario use and identifying capacity building approaches.**

1.1 BOTSWANA

Institution responsible for long-term energy planning	Ministry of Mineral Resources, Green Technology and Energy Security
Most recent official energy planning document	• National Energy Policy (NEP) (Ministry of Mineral Resources, Green Technology and Energy Security, 2021)
Good practices for developing scenarios and planning	• Intersectoral collaboration during the elaboration of energy plans • Participation of relevant stakeholders during energy scenarios assessment • Development of two broad scenario categories: energy demand and energy supply scenarios • Development of energy scenarios aligned with national development and environmental goals • Identification of different channels for communication of scenario results, depending on the stakeholder

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

In Botswana, a steering committee and a multisectoral technical team co-ordinate the development of LTES

In Botswana, the Ministry of Mineral Resources, Green Technology and Energy Security is responsible for long-term energy planning. This ministry, through the permanent secretary, chairs the project steering committee, which supervises the development of energy plans.

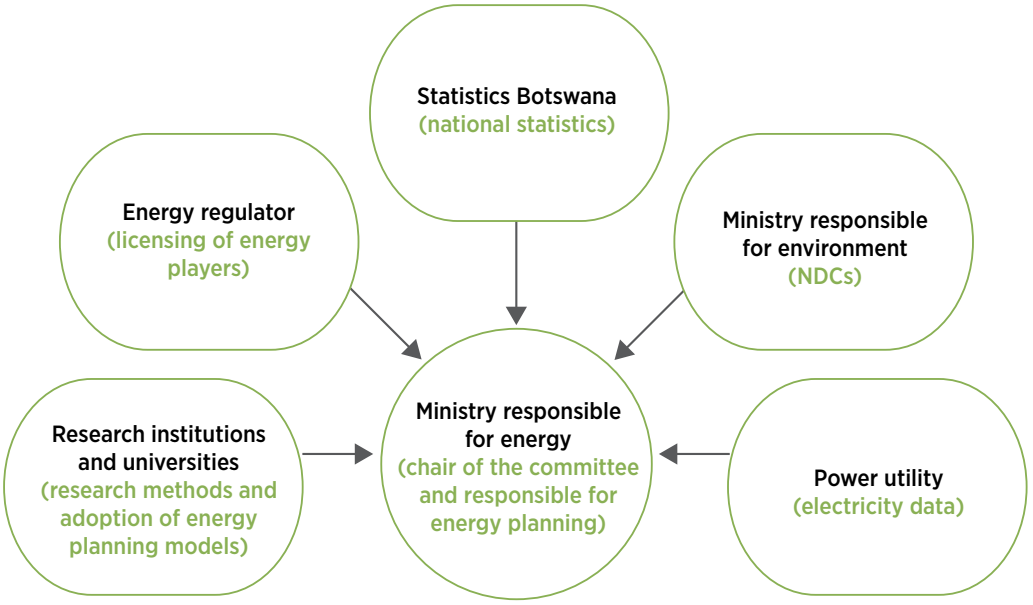
The committee oversees the project technical team, which develops LTES. Both the steering committee and the technical team are composed of representatives from different sectors, who collaborate during the development of energy scenarios, as illustrated in Figure 2. For example:

- The power utility provides energy data, while the environment ministry offers guidance on the environmental requirements that must be considered during energy scenario development and planning.

- The Office of Statistics Botswana assists in the collection and interpretation of demographic and socio-economic data.

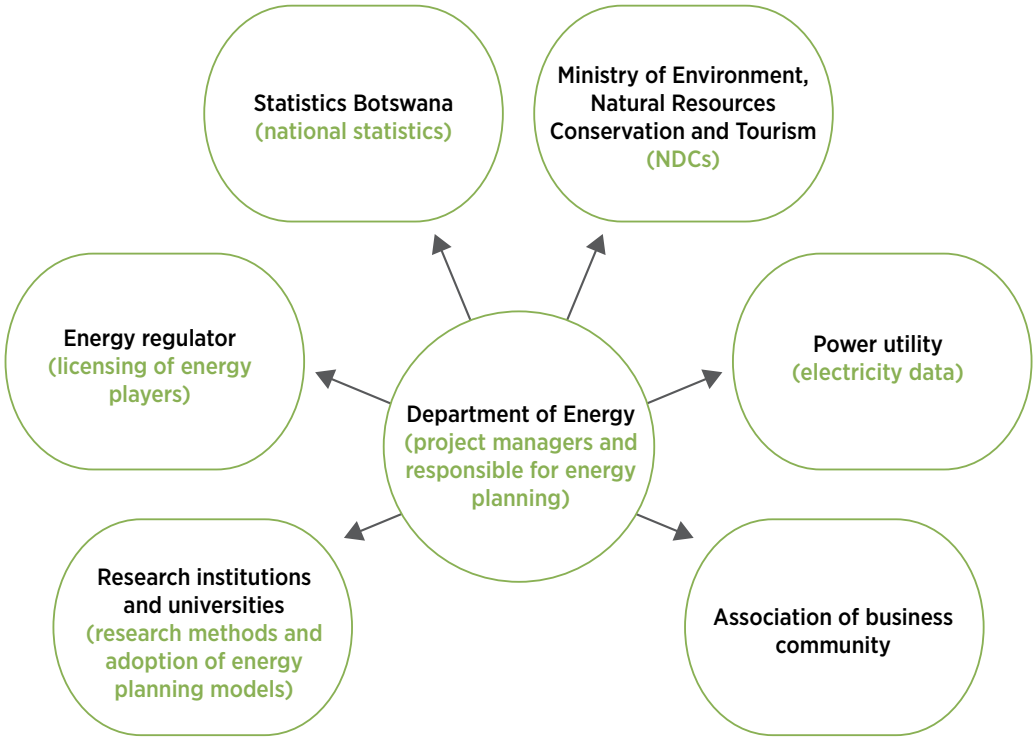
- On the other hand, the research institutions and universities are responsible for developing research methods and implementing energy planning models. A differentiating factor is that the project technical team includes representatives from the private sector through a business association community.

Figure 2a Structure of the project steering committee in Botswana



Source: Setlhare (2021).

Figure 2b Structure of the project technical team for energy planning in Botswana



Source: Setlhare (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

LTES in Botswana are defined by national development goals, environmental goals, energy policy, and demographic and socio-economic scenarios

The LTES in Botswana are aligned with the national development goals set in Vision 2036. This agenda envisions the transformation of Botswana into a high-income country with an export-led economy. Furthermore, the environmental goals defined in the nationally determined contribution (NDC) and the Sustainable Energy for All (SE4All) Action Agenda are considered in the LTES. Energy scenarios are also defined by the current energy policy, which includes the Renewable Energy Policy, Renewable Energy Strategy and Energy Efficiency Strategy. Other national targets – such as universal access to electricity, and reliability and security in the supply of electricity by 2030 – are also included. Finally, demographic and socio-economic scenarios are considered. To account for changes in these factors, the LTES are updated annually.

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

Botswana has two broad types of scenarios accounting for both energy demand and energy supply

- The energy demand scenarios presented were the Optimistic Scenario, Energy-Based Measures and the Alternative/Pessimistic Scenario.

- Energy supply scenarios presented were Minimum Constraint, Clean Electricity and Self-Sufficiency.

A combination of both demand and supply scenarios allows for the assessment of the impact on the environment and costs. After results are developed, policy makers are able to compare this against existing policy and choose a scenario in line with national goals.

Pillar 2.2 Improving scenario use – transparent and effective communication

In Botswana, the LTES are communicated to relevant stakeholders using different channels

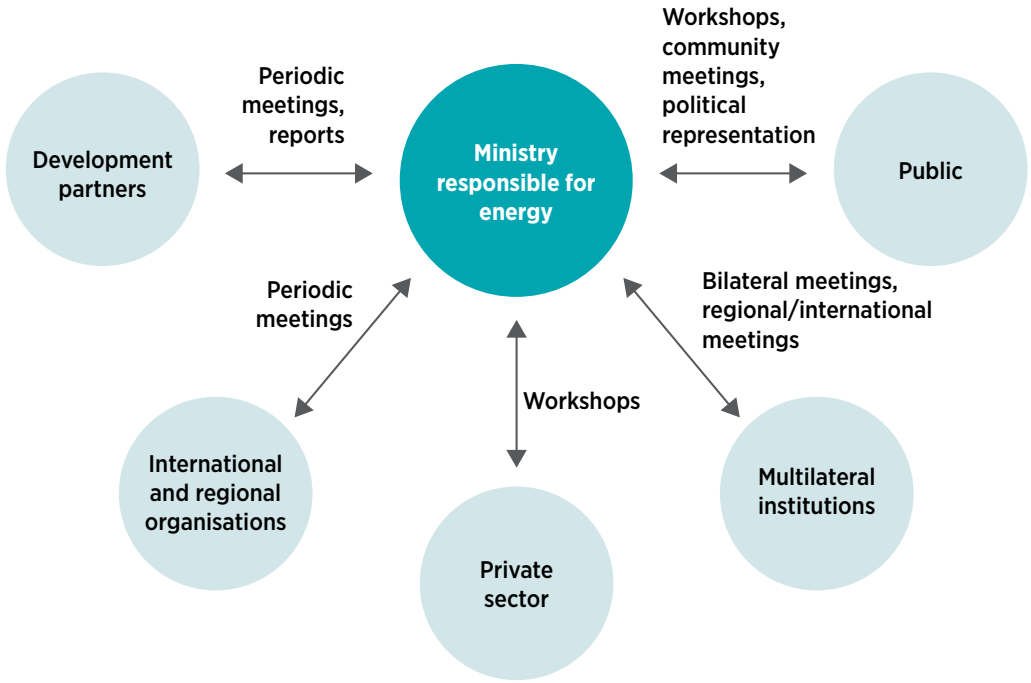
To communicate the LTES, Botswana has identified relevant stakeholders involved in energy planning.

A diverse group of stakeholders is consulted to ensure that planners obtain a variety of views. For instance, the business community would advocate for affordable energy while multilateral financial institutions are more focused on investing in a transparent manner. As presented in Figure 3, the Ministry of Mineral Resources, Green Technology and Energy Security has established different channels for communicating the LTES to ensure a transparent process.

- As part of the communication strategy, periodic meetings and reports are used to communicate the results with development partners such as the the International Atomic Energy Agency (IAEA) and Southern African Development Community (SADC). Bilateral meetings at the regional and international levels are organised with multilateral financing institutions.

- Communication with the private sector is achieved through workshops, sectoral and national meetings at the ministry level and the presidential level. On the other hand, communication with the public is carried out via workshops, community meetings and through political representatives. Input from the public informs the national development plans.

Figure 3 Channels for communicating energy plans to stakeholders used by Botswana



Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

Botswana's energy planning team is constantly trained to ensure the building and retention of skills

To strengthen capacities in the development of energy scenarios and use of energy planning tools, Botswana has established a project technical team. The technical team is composed of the Department of Energy, which is responsible for co-ordination of project team activities, and other government departments, research institutions and universities. Team members are constantly trained, refreshed or retrained to ensure that skills are locally retained. To build capacities on a broader scale, universities are starting to disseminate the methodologies and models used for energy planning through continuing training programmes.

1.2 EGYPT

Institution responsible for long-term energy planning	Supreme Council for Energy
Most recent official energy planning documents	• The Integrated Sustainable Energy Strategy (ISES) 2035 is being updated (not available online as of December 2022) • Sustainable Energy Project (Goverment of Egypt, 2022)
Good practices for developing scenarios and planning	• Responsible organisational structure and enabling framework • Continuous measurement and evaluation of energy sources used • Participation of all sectors involved in scenario development • Inclusion of cost-benefit analysis and social and environmental impacts in the development of scenarios • Continuous revision and update of the strategy

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

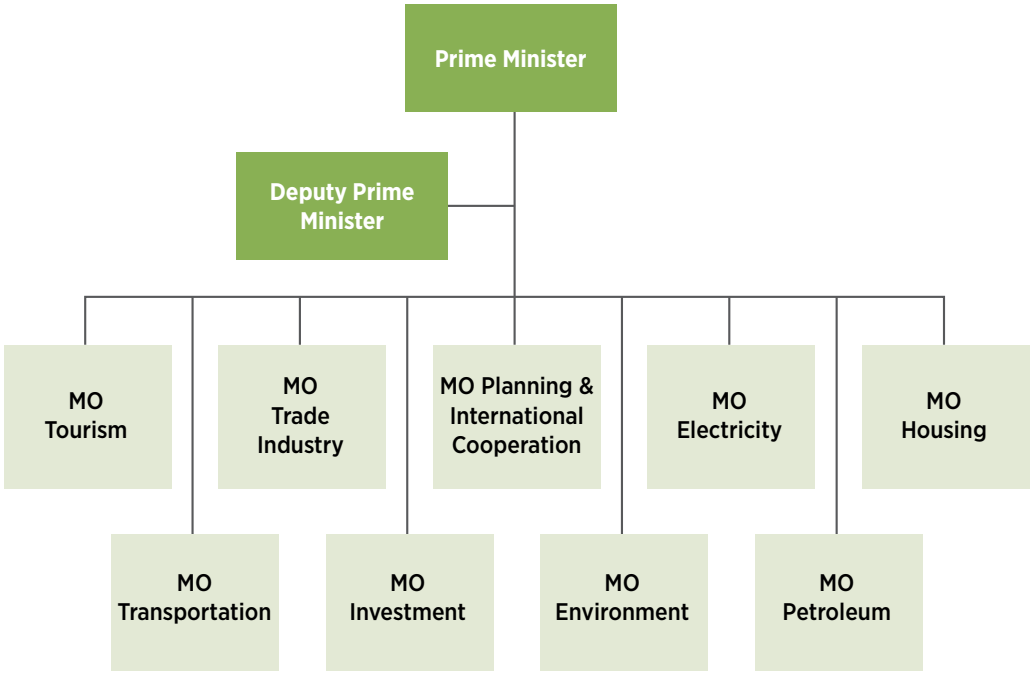
Egypt has an integrated mid-term energy strategy, which is developed and updated continuously in co-ordination with various ministries

In Egypt, the Supreme Council for Energy reviews and approves national energy strategies and policies. This council is led by the prime minister and is made up of different ministries, as presented in Figure 4. In October 2016, this entity approved the Integrated Sustainable Energy Strategy (ISES) 2035.

The ISES is implemented by the Ministry of Electricity & Renewable Energy and the Ministry of Petroleum & Mineral Resources. Both ministries work in collaboration with other public entities and promote consultation with the private sector, non-governmental organisations and international organisations.

For the development of the most recent energy strategy, four scenarios with different priorities in key technologies were assessed by members of the Supreme Council. The scenarios are: Alternatives for Renewable Energy Sources; Postponing the Use of Nuclear and Renewable Energy Sources Reliance on High Production of Electrical Energy; Focus on Renewable Energy Sources and Electric Energy; and the All-Alternatives Scenario. The official strategy is based on the least-cost scenario, which uses a modelling framework that centralises the data and decision in the Integrated MARKAL-EFOM System (TIMES)-Egypt tool.

Figure 4 Structure of the Egyptian Supreme Council for Energy



Note: MO = ministry.
Source: Ramadan and Ahmed (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

Egypt has aligned its energy strategy with the country's Vision for 2030 and goals for the achievement of SDGs. The country aims to increase the renewable energy share in the power matrix by 2035

The ISES 2035 is aligned with Egypt's Vision 2030, which aims to promote economic prosperity based on justice, social integrity and participation (Sever-Mehmetoglu, 2022; UN Egypt, 2022). Similarly, the ISES 2035 seeks to contribute to the achievement of the SDGs.

Based on that, the government of Egypt aims to increase the share of renewable energy in the power mix to 42% by 2035. The scope of planning scenarios is adjusted accordingly to include all technologies considered to meet this goal. The increased participation is expected to come mainly from the deployment of solar PV, CSP, and wind and hydropower plants (Sever-Mehmetoglu, 2022). By transitioning to renewable energy use, the country seeks to enhance its sustainable economic growth and to increase jobs.

The ISES is updated every two years to factor in changes including gross domestic product (GDP) growth rate; population growth rate; availability of new technologies and their capital cost; and prices of international crude oil, imported gas and coal. The basic elements considered in the scenarios assessed during the ISES formulation are oil and natural gas production, energy subsidies, coal availability for power generation, nuclear energy, renewable energy and energy efficiency. Egypt is also engaging in negotiations and agreements with other countries to expand the grid interconnections across the Arab region (Hasan, Al-Aqeel and El Salmawy, 2020).

Pillar 2.2 Improving scenario use – transparent and effective communication

Egypt communicates the scenario used for the formulation of the official energy strategy via workshops with stakeholders and government agencies' websites

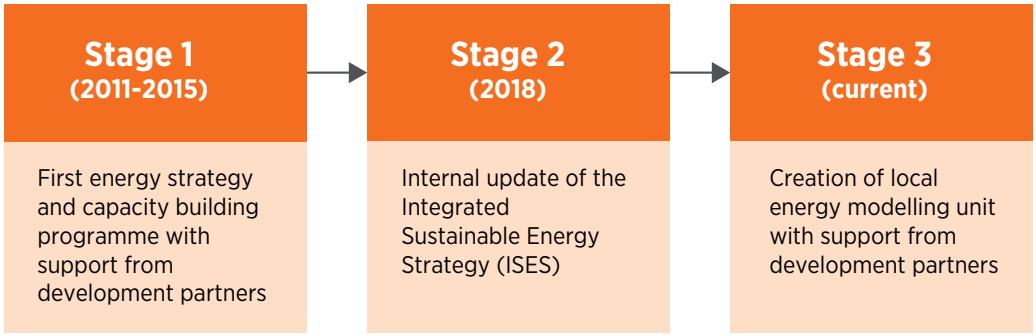
During the preparation of the ISES, different scenarios are built and compared with the purpose of discussing how to enhance energy security through diversification of supply sources, guarantee sustainability and promote the establishment of competitive markets. The scenario used for the formulation of the ISES is communicated to the public via workshops and media, including the websites of ministries and government agencies. To improve communication and transparency during the energy planning process, Egypt is working to restructure some of the involved entities with the aim of building an integrated information system.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

The country is transitioning from outsourcing skills to building in-house capacity through the establishment of a local energy modelling unit

One of Egypt's current challenges is to establish an entity responsible for energy scenario development, energy planning, energy strategy and policy formulation. Capacity building in energy planning may be presented in three stages, as illustrated in Figure 5. In the first stage, Egypt received advice from foreign experts to elaborate the first energy strategy document and started the capacity-building programme. In the second stage, during the update of the ISES in 2018, the country began handling the process internally with support from foreign experts. Currently, Egypt is in the third stage, which involves the establishment of a local energy modelling unit with support from the European Union (EU). This unit will consist of employees from relevant sectors preparing energy scenarios using previously developed tools.

Figure 5 Stages for capacity building in energy strategies in Egypt



1.3 ESWATINI

Institution responsible for long-term energy planning	Ministry of Natural Resources and Energy
Most recent official energy planning document	• Kingdom of Eswatini Energy Master Plan 2034 (Ministry of Natural Resources and Energy, 2018)
Good practices for developing scenarios and planning	• Frequent update of input data to develop updated energy scenarios • Assistance from international organisations to build capacities and use multiple modelling tools • Active participation of local institutions related to energy planning • Inclusion of new technologies in scenarios assessment to ensure a sustainable transition • Use of local data collected from energy survey instead of using international statistics

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

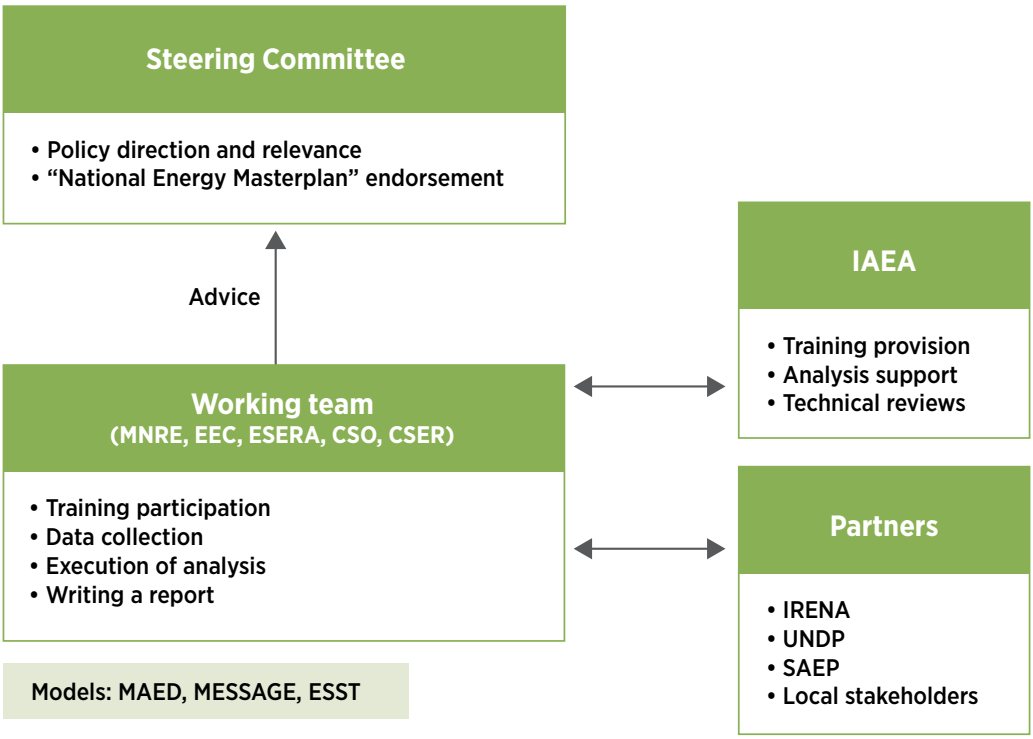
The National Energy Master Plan of Eswatini contains scenarios up to 2034. The plan was developed with the participation of local and international partners

The Ministry of Natural Resources and Energy is the institution responsible for the development of energy scenarios in Eswatini. This institution led the formulation of the National Energy Master Plan, which integrates all the energy sectors. This document, published in 2018, contains energy scenarios up to 2034. The implementation framework of the Energy Master Plan 2034 (Ministry of Natural Resources and Energy, 2018) is presented in Figure 6. A steering committee was established, which provided policy direction.

- The committee is advised by a working team, which is formed by the Ministry of Natural Resources and Energy, Eswatini Energy Regulatory Authority, Central Statistics Office, University of Eswatini and the Centre for Sustainable Energy Research. The team was responsible for energy scenario modelling training, continuous data gathering, model execution and report drafting. Close contact with local and international stakeholders (IAEA, IRENA, United Nations Development Programme [UNDP], etc.) was maintained at different stages of the process for technical reviews.

Under the National Energy Master Plan (Figure 6), the country is updating the Energy Master Plan to expand scenarios from 2034 to 2050. For this last version, the data storage and documentation of scenario assumptions processes were improved. Figure 7 presents the development process of the Energy Master Plan 2050. It started in 2018 with the project inception and continued during 2019 with data collection. A final draft is expected to be submitted to the government cabinet in 2022 for approval. This update is being conducted in line with the Global Net Zero Emissions 2050 scenario, which explores a pathway for the global energy sector to achieve net-zero carbon dioxide (CO_2) emissions by 2050 (IEA, 2021).

Figure 6 Implementation framework for the formulation of Eswatini's Energy Master Plan 2034



Notes: SAEP = South African Education Project; MNRE = Ministry of Natural Resources and Energy; EEC = Eswatini Electricity Company; ESERA = Eswatini Energy Regulatory Authority; CSO = Central Statistics Office; CSER = Centre for Sustainable Energy Research (University of Eswatini).
Source: Khumalo (2021).

Figure 7 National Energy Master Plan of Eswatini development process with scenarios to 2050

Source: Khumalo (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

Renewable technologies and updated local data are included to assess energy transition scenarios.

The Energy Master Plan 2050 considers updated data on solar and wind generation potential to present the long-term expansion of installed capacities as well as a detailed analysis of energy demands that includes the non-power sectors.

Eswatini conducts a national energy survey to collect data on biomass resources and deployment of small-scale power generation facilities based on off-grid solar PV. This survey permits Eswatini to use more accurate data during the phase of energy scenarios modelling instead of using estimates based on international statistics. The initial survey lasted two years; however, the latest update survey lasted one year because data are continuously collected to ensure efficiency.

Eswatini's energy system integrates neighbouring countries such as Mozambique and South Africa, from which the country imports energy.

Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

The purpose of the scenarios assessed in the Energy Master Plan of Eswatini is to guide future investments towards a sustainable energy transition

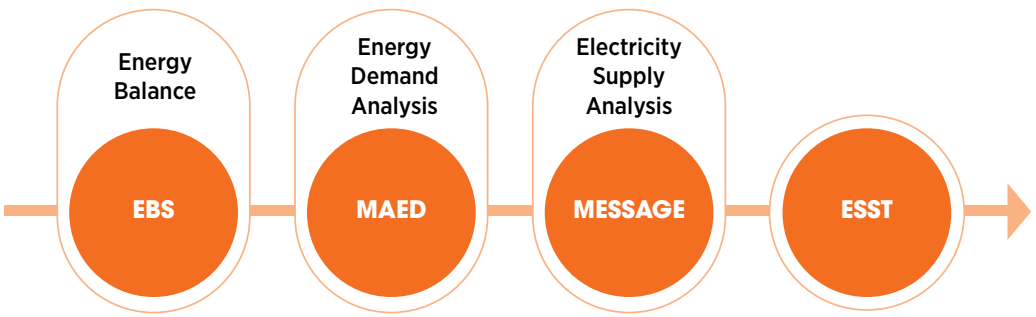
The assessment of diverse integrated energy scenarios during the development of the Energy Master Plan of Eswatini enabled the identification of investment priorities aimed at expanding energy sector infrastructure, especially in the power sector by using local renewable energy potential. In the power sector, this long-term expansion plan is a basis to formulate the short-term operation plan, which seeks to guarantee reliable energy supply. This plan provides guidance up to 2050 for investors, industry, utilities and policy makers, among others.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

Eswatini gained capacity from international institutions, which supported the formation of working teams specialised in LTES

Eswatini received assistance from the International Renewable Energy Agency (IRENA) to form working teams specialised in LTES and planning tools, primarily using the Low Emissions Analysis Platform (LEAP) and system planning test (SPLAT)-Eswatini models (based on the MESSAGE platform). IRENA played a key role in the development of the Energy Master Plan 2034, while the IAEA provided the required technical assistance for the Energy Master Plan 2050. The IAEA also trained the working team in the use of the MAED and MESSAGE modelling tools for energy demand analysis and energy supply modelling, respectively. Additionally, Eswatini uses the Energy Scenarios Simulation Tool (ESST) in modelling. Eswatini also co-operates with other international stakeholders, such as the UNDP and, recently, the South African Education Project (SAEP). Eswatini develops scenarios using the different tools and ensures that they feed into each other for more accurate and concise scenario development, as illustrated in Figure 8.

Figure 8 Eswatini's scenario development methodology using multiple tools



1.4 GHANA

Institution responsible for long-term energy planning	Energy Commission of Ghana
Most recent official energy planning document	• Integrated Power Sector Master Plan (IPSMP) (Energy Commission of Ghana, 2018)
Good practices for developing scenarios and planning	• Institutionalised and highly collaborative process, engaging key sectors in energy planning • Elaboration of energy plans as a cyclic process that evolves according to variations in energy supply or demand • Continuous planning process results in consecutively shorter timelines • Consultation processes with stakeholders from an early stage • Use of a least-regret strategy to develop energy plans

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

Energy planning in Ghana is built through a highly collaborative process led by the government. In this process, key personnel from different sectors participate at technical and executive levels

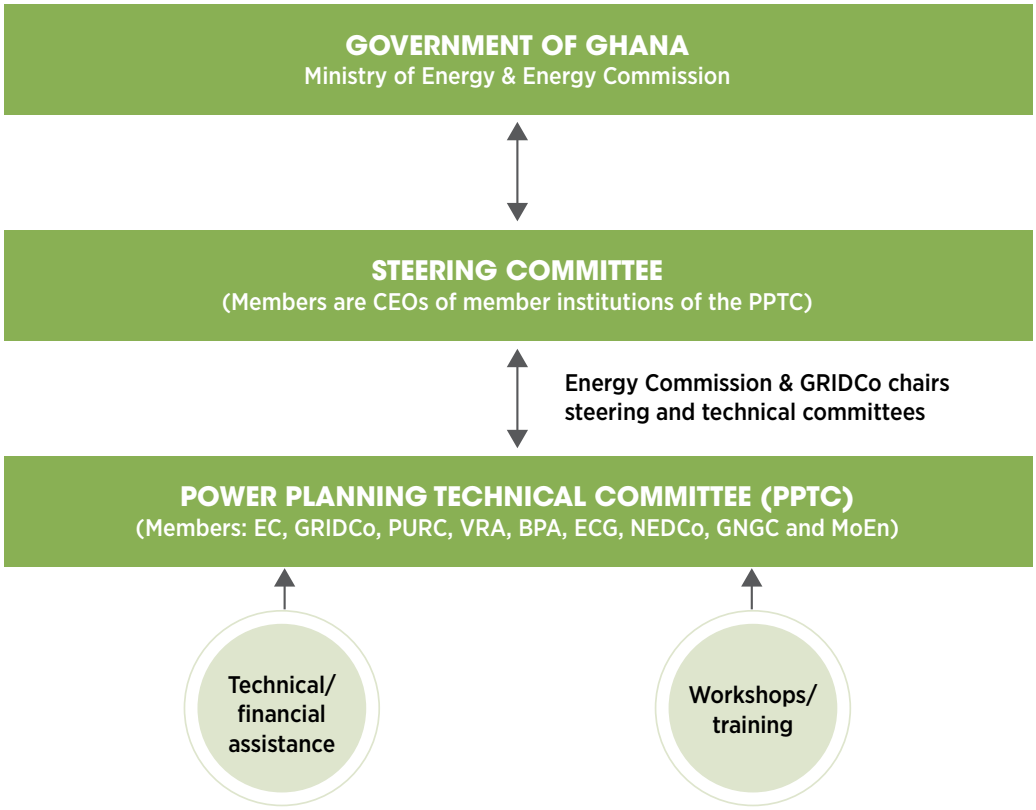
Ghana has institutionalised a bottom-up collaborative process to develop power plans. Under this framework, the Energy Commission leads the development of the Integrated Power Sector Master Plan (IPSMP), which was launched in 2018 and updated in 2019. This long-term expansion plan received technical and financial support from United States Agency for International Development (USAID) through the Integrated Resource and Resilience Planning (IRRP) programme.

The governance structure for power planning in Ghana is chaired by the Ministry of Energy and the Energy Commission (Figure 8). These institutions oversee the Steering Committee and the Power Planning Technical Committee (PPTC). Both committees are composed of key personnel from different sectors, including the grid operator, the economic regulator, independent private producers and others. This governance structure ensures sustainability in power planning and engages sectoral leaders all along the planning process, generating ownership of the IPSMP.

Meetings to share results are intended for representatives from academia, civil society organisations, research institutions and development partners. This allows the government to engage with stakeholders at an early stage and helps to build trust and consensus around the scenario development process. Figure 9 represents the guidelines followed by the PPTC during the development of energy plans. These meetings ensure that conflicting views are presented and discussed to ensure balanced scenarios that account for different contexts and a more collaborative approach.

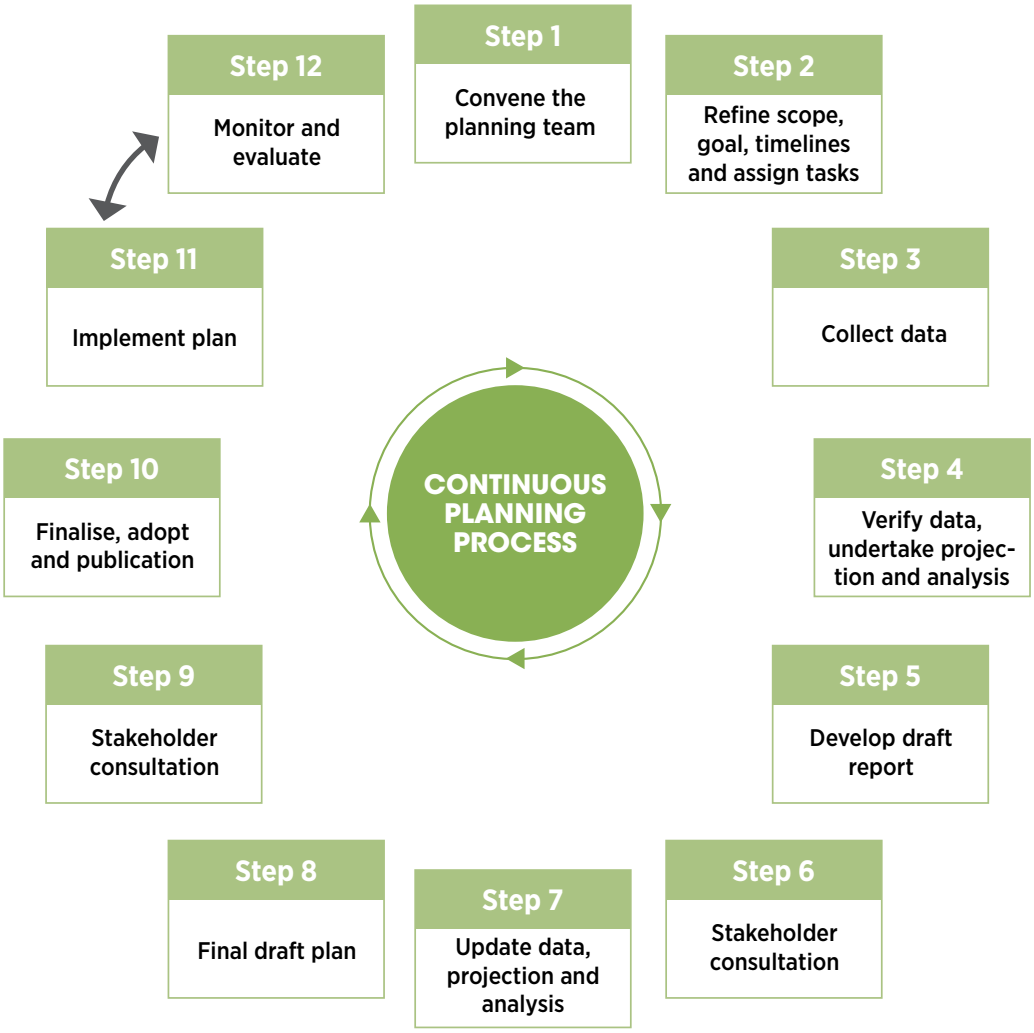
Ghana's planning process is continuous, evolving based on variations in the supply and demand of electricity. The cycle starts by assembling the planning team. This team determines the scope of the scenarios and planning. Next, the data are collected, verified and analysed and a draft report is prepared. This report is subjected to a double consultation process with stakeholders. Once the report is accepted, the plan is adopted and published, and the cycle starts again. The continuous process results in consecutively shorter timelines.

Figure 9 Governance structure for energy planning in Ghana



Notes: EC = Energy Commission of Ghana; GRIDCo = Ghana Grid Company, Ltd.; PURC = Public Utilities Regulatory Commission; VRA = Volta River Authority (VRA); BPA = Bui Power Authority; ECG = Electricity Company of Ghana (ECG); NEDCo = National Electricity Distribution Company; GNPC= Ghana National Petroleum Corporation (GNPC); GNGC = Ghana National Gas Company Ltd.; and MoEn = Ministry of Energy.
Source: Attieku (2021).

Figure 10 Guidelines followed by the PPTC for the development of energy plans



Source: Attieku (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

The development of energy plans in Ghana is based on scenario assessments, which consider financial metrics, national strategic considerations, and environmental and social goals

The planning team is responsible for defining the scope of the scenarios considered for the IPSMP. The scenarios evaluated during the process include first a reference scenario; secondly, specific energy scenarios (*e.g.* diversification of the power matrix, nuclear, coal);

and finally, scenarios for emissions reduction, which include renewable energies and new technologies. The scenarios are compared using financial metrics, national strategic considerations (*e.g.* national security, supply diversity, economic goals), environmental goals (*e.g.* reduced carbon emissions), or social considerations (*e.g.* equity, creation of jobs) (Energy Commission of Ghana, 2018).

Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

Among a set of analysed scenarios, Ghana chooses the least-regret scenario when formulating its power expansion plan

During the development of the IRRP, the analysis of energy scenarios through the utilisation of a decision framework led to the development of a common least-regret electricity generation expansion plan. This is the plan that meets the power sector policy objectives and minimises the risks to operative issues in the grid under a broad range of potential technology, economic and climate futures (Energy Commission of Ghana and Strategic Consulting for a Digital World, 2018). The scenarios change and are updated based on the prevailing policy and the recommendations of the PPTC and the Steering Committee. For instance, the scenario relating to coal usage may be dropped in the next cycle because it does not align with the current climate policy.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

To build capacity in energy planning and scenarios development, the PPTC receives training from development partners and academia

The PPTC is trying to strengthen local capacity in energy planning. The team members periodically undergo training and attend workshops to ensure their skill sets are up to date. The training is provided by development partners such as USAID, IAEA, SADC and local academic institutions. The PPTC members are trained in several planning tools, such as LEAP, MESSAGE, the Integrated Planning Model (IPM), and, from January 2022, PLEXOS.

1.5 KENYA

Institution responsible for long-term energy planning	Ministry of Energy Ministry of Petroleum and Mining
Most recent official energy planning document	• Least Cost Power Development Plan (LCPDP 2021) (Ministry of Energy of Kenya, 2021)
Good practices for developing scenarios and planning	• Participation of public and private sector actors in energy plan development • Formation of planning teams with varied backgrounds • Combination of outsourcing and insourcing methods for capacity building in scenarios modelling • Development of an Integrated National Energy Plan (INEP) through a collaborative approach • Joint working model with consultants to ensure knowledge and skills transfer

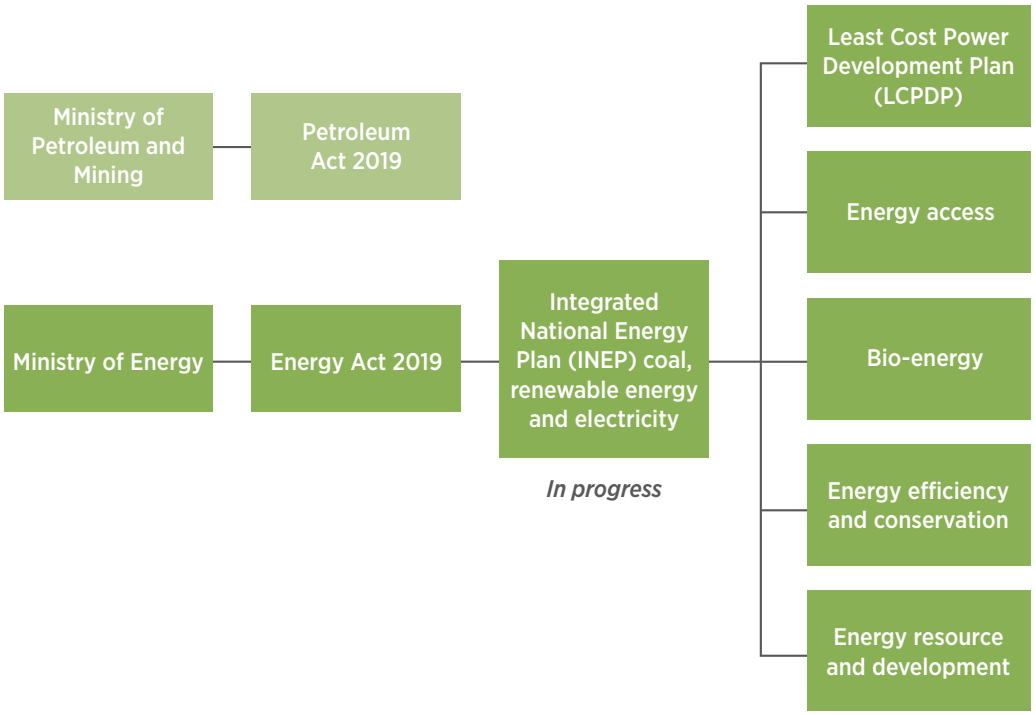
Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

Kenya is preparing an INEP that comprises a sectoral plan for the optimal expansion of the power system

Energy planning in Kenya is co-ordinated by the Ministry of Energy and the Ministry of Petroleum and Mining. The Energy Act 2019 and Petroleum Act 2019 constitute the regulatory framework for the energy sector at the national and sub-national levels.

The Energy Act 2019 provides the basis for the development of the INEP, which is currently under preparation by the Ministry of Energy. This integrated plan aims to provide guidance for the development and expansion of new infrastructure and to foster energy efficiency. It seeks to consolidate both national energy service provider plans and county energy plans. As illustrated in Figure 11, the INEP contains five planning components: the LCPDP, energy access, bioenergy, energy efficiency and conservation, and energy resource and development. While the LCPDP is already in place, the other four components are still being formulated. The LCPDP sets the guidelines for generation and transmission planning for the next 20 years. The energy scenarios contemplated for the elaboration of the LCPDP explore different power sector development pathways.

Figure 11 Framework for the formulation of the Kenyan INEP



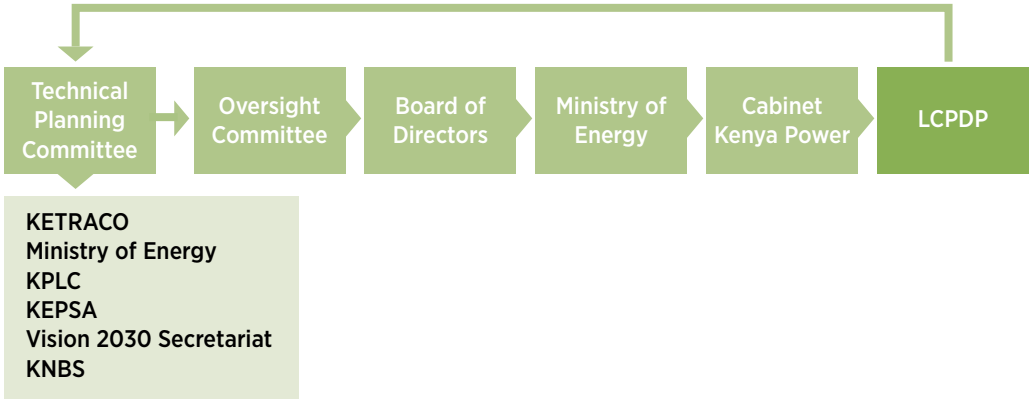
Kenya is developing the power sector plan (LCPDP) through a collaborative process that includes private and public institutions

Kenya has a solid governing structure that ensures a participative process during the preparation and approval of the LCPDP, as illustrated in Figure 12. The plan is developed by a Technical Planning Committee composed of utilities such as the Kenya Power and Lighting Company (KPLC), the Kenya Electricity Transmission Company (KETRACO) and the Ministry of Energy, among others. This team carries out energy scenarios simulations and draft reports.

The Technical Planning Committee is guided by an oversight committee formed by senior experts who review and approve the technical reports. Thereafter, the report is submitted for approval to the board of directors of all participating public agencies, who issue a resolution. If the resolution is positive, the report is submitted to the Ministry of Energy, and, eventually, to the cabinet responsible for Kenya's power issues.

The LCPDP is updated every two years, through the same process. In addition to the LCPDP committees, other institutions such as the Kenya Private Sector Alliance (KEPSA), the Vision 2030 Secretariat and the Kenya National Bureau of Statistics (KNBS) participate in the development and continuous updating of the plan as members of the oversight committee.

Figure 12 Overview of the development process of the LCPDP of Kenya



Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

Scenario building considers interlinkages with other national and sectoral plans to ensure consistency and better inform the formulation of policies in the power sector

The scenarios assessed during the development of the LCPDP considered wider national development goals. Thus, the LCPDP 2021 considers the linkages between the power sector and other national and sectoral development plans. The plan informs the formulation of national targets and energy sectorial policies on a medium- to long-term scale. This least-cost plan provides guidance to stakeholders on the actions that must be taken to meet national needs.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

Teams working on energy planning have partnerships for training and the acquisition of energy planning tools

- The members of the Technical Planning Committee continuously engage with development partners for training and acquisition of new computational tools. The team has competencies in demand forecasting, generation expansion planning, transmission expansion planning and financial modelling. Having the Technical Planning Committee dedicated to energy planning allows for continuity in this area. The committee comprises representatives from the sector utilities.

- The Energy and Petroleum Regulatory Authority has been co-ordinating the team since its establishment in 2009. However, this changed recently when the role of co-ordination was transferred to KPLC following a recommendation of the Presidential Task Force on the Review of Power Purchase Agreements. When the committee works with consultants, they partner to ensure knowledge and skills transfer.

- The energy planning team engages with local universities and research bodies. These collaborations seek to create energy planning units in other institutions, creating capacities to develop and assess energy scenarios.

1.6 MOROCCO

Institution responsible for long-term energy planning	Ministry of Energy, Mines and Environment
Most recent official energy planning document	• Nationally Determined Contribution (NDC 2021) (Royaume du Maroc, 2021)
Good practices for developing scenarios and planning	• Participative process during NDC formulation as energy planning is closely linked to the climate change response • Integrated modelling approach to formulate mitigation scenarios • Frequent update of the NDC, including new sectors such as phosphates and cement • Online platform for monitoring the implementation of the NDC • Collaboration with international organisations to strengthen local capacity

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

In Morocco, in the context of the NDC formulation process, mid-term energy scenarios within the mitigation goals were assessed in a participative scheme with relevant stakeholders

A set of energy scenarios in Morocco were recently developed under the framework of the NDC formulation process. This document was last updated in 2021 and presents mitigation scenarios up to 2030. The methodology used to develop and update the NDC is illustrated in Figure 13.

- The starting point is the political decision to commit to mitigation and adaptation measures in response to climate change.
- This is accompanied by extensive stakeholder consultation from the government, civil society and the private sector. The consultative process allows for the gathering of required technical information and review of the policies and programmes intended to mitigate climate change. Consultations for the current NDC ran between 2019 and 2021 and resulted in bilateral consultations, a series of workshops and different exchanges to gather data that would inform the new NDC.

- Energy scenarios are used for the analysis of emissions mitigation potential and of the benefits of actions and programmes proposed in the energy sector. After consultation, reports containing technical, economic and social information are prepared by the Ministry of Energy, Mines and Environment.

- Finally, these reports are sent for approval by the competent party. The NDC development and updating process is co-ordinated by the National Climate Change and Biodiversity Commission, the National System for the Inventory of Greenhouse Gases, and the National Commission for Sustainable Development.

Figure 13 Methodology for the development of the Moroccan NDC

Source: Machkori (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

The energy scenarios model all the relevant activities in the energy consumption sectors to calculate specific greenhouse gas (GHG) production

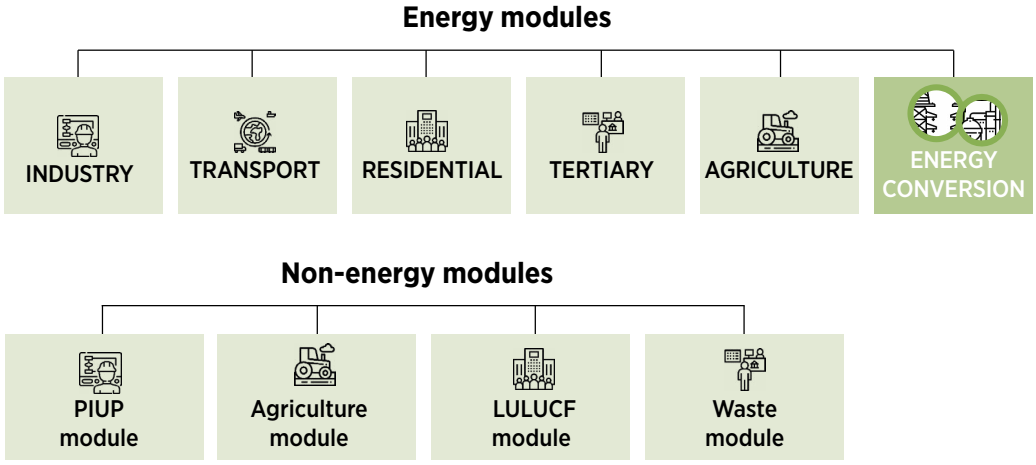
Figure 14 presents the GHG producing sectors, grouped into two modules considered in the Moroccan mitigation scenarios.

- The "energy module" includes industry, transportation, residential, tertiary/service sector, agriculture and energy transformation (*e.g.* refining and distribution).

- The "non-energy module" covers all the other sectors and activities that generate methane, nitrous oxide and other GHGs (*e.g.* agriculture, waste).

The energy scenarios consider demographics, macroeconomic projections, economic indicators and specific sectoral data. Morocco has used an innovative modelling approach to also include emissions from the phosphate and cement industries.

Figure 14 Sectors considered during the modelling of mitigation scenarios for the Moroccan NDC



Notes: LULUCF = land use, land use change and forestry, PIUP = industrial processes and product use.
Source: Machkori (2021).

Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

Morocco develops energy scenarios to assess climate change mitigation actions and strategic decisions to foster structural changes in the energy sector

The use of energy scenarios in Morocco during the NDC formulation process seeks to inform the debate around defining national goals for the energy sector.

- For instance, Morocco aims to reduce dependency on fossil fuels imports and to enhance the deployment of renewable energies. The analysis of the emissions mitigation scenarios enables the design of activities and initiatives to accelerate sustainable economic development and the energy transition.

- In parallel, Morocco has established an online measurement, reporting and verification (MRV) platform to monitor the NDC implementation. In addition, the country has implemented an energy information system that facilitates the research conducted by institutions such as the Moroccan Observatory of Energy.

Pillar 3.1

Identifying capacity-building approaches – building the right type of scenario capacity in government

Morocco has collaborated with international organisations to build capacities in energy planning and long-term energy scenario development

Morocco builds local capacity in energy planning in collaboration with international organisations such as IRENA, Eurostat and the African Energy Commission (AFREC), among others. LEAP software is used to assess the emissions mitigation scenarios. To assess the greenhouse emissions from the phosphate and cement sectors, the country uses the EX-Ante Carbon-balance Tool (EX-ACT).

1.7 NIGERIA

Institution responsible for long-term energy planning	Energy Commission of Nigeria
Most recent official energy planning document	• National Energy Master Plan 2020 (NEMP) (Energy Commission of Nigeria, 2020)
Good practices for developing scenarios and planning	• Collaboration between relevant stakeholders for the development and validation of scenarios • Frequent update of energy plans to account for changes in the economy and demography • Consideration of environmental and economic policies as delimiting factors during scenario development • Inclusion of technologies that tackle poverty and inequity in energy scenarios • Strengthening of local capacities rather than outsourcing

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

Nigeria has established a solid governance structure that encourages energy planning to be developed as part of national planning

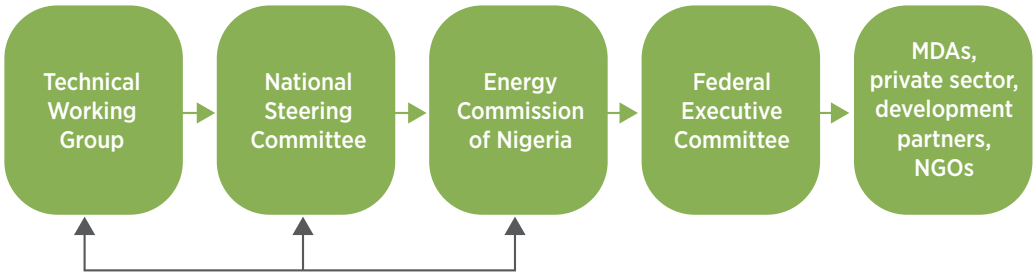
Nigeria's governance structure includes energy planning as part of national planning under the Federal Minister of Finance, Budget and National Planning. This ensures the development of broader and more reliable LTES.

The Energy Commission constructs these scenarios to inform the development of the NEMP and the formulation of national policies, as illustrated in Figure 15. The NEMP produces inputs that are included during the development of other sub-sectoral plans. This process is carried out with the participation of ministries, departments and agencies (MDAs), the organised private sector and civil society organisations. These institutions provide data used when setting up relevant scenarios.

Once the plans are drafted, the Technical Implementation Committee presents the preliminary results to the National Steering Committee, which is responsible for presenting the plans to the Energy Commission of Nigeria and finally to the Federal Executive Council

for approval. When the plans are approved, they are budgeted by the Federal Minister of Finance, Budget and National Planning. Among the MDAs that participate in the energy planning process, the Ministry of Petroleum, Ministry of Power, Ministry of Environment and Ministry of Mines have key roles.

Figure 15 Governance structure for the development of Nigeria's NEMP

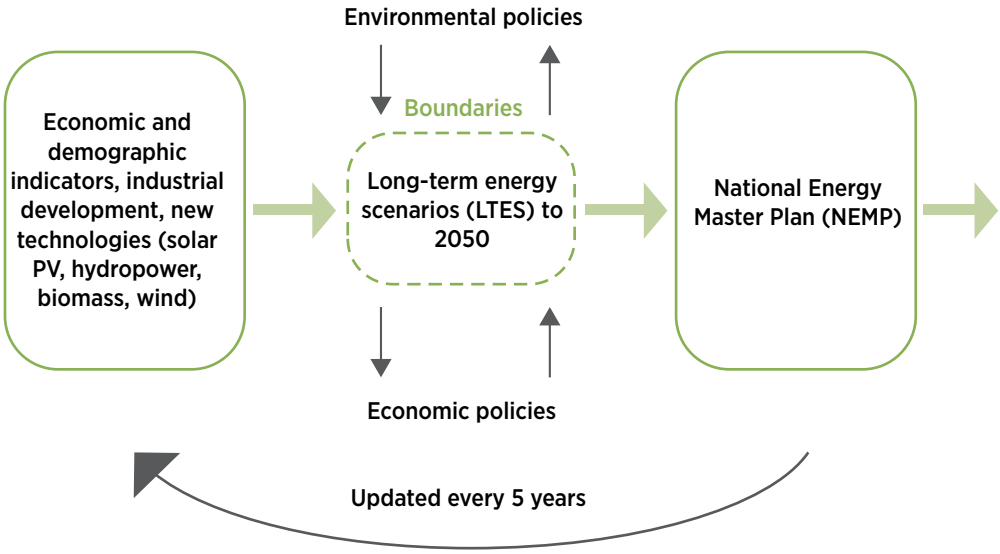


Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

Nigeria is improving the NEMP through a robust assessment of LTES up to 2050

To develop the NEMP, Nigeria assesses a set of energy scenarios delimited by economic and environmental national policies. As part of the country's Agenda 2050, Nigeria is currently updating the NEMP with scenarios up to 2050. As illustrated in Figure 16, during the development of the LTES, factors such as the economy, demography, industrial development paths and environmental policies are considered. Because of these changing factors, Nigeria updates the NEMP every five years. The LTES consider the deployment of technologies such as solar PV, hydropower, biomass and wind. To tackle poverty and inequity during the energy transition, the role of fuels such as gas and biofuels is assessed during scenario development.

Figure 16 Boundaries for the development of LTES in Nigeria



Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

One of the purposes of the use of LTES in Nigeria is to explore a wide set of possible decarbonisation trajectories from 2020 to 2050, including the evaluation of innovative technologies and different levels of ambition in climate goals

In Nigeria, energy scenarios are built to serve different purposes: 1) to plan the required infrastructure development; 2) to assess future energy demand; 3) to guide the development of long-term national integrated master plans; 4) to explore alternative scenarios (available in the 2050 calculator) (Energy Commission of Nigeria, 2022); 5) to raise the ambition of the private sector; 6) to drive innovations in terms of investment and technology; and 7) to socialise different visions of the future with the community. The communication of scenario results is usually done through publications on the websites of ministries and government agencies, and in seminars and workshops. At these events relevant stakeholders validate the findings and raise awareness about the scenarios.

Pillar 3.1

Identifying capacity-building approaches – building the right type of scenario capacity in government

Nigeria has received training from international organisations on energy planning tools. The capacity is mainly hosted by the Energy Commission of Nigeria, and the country seeks to strengthen this local capacity

The planning capacity in Nigeria is hosted by the Energy Commission. The energy planning team received assistance on planning tools, such as MAED and MESSAGE, from the IAEA. In 2013, the United Kingdom's Department of Business, Energy and Industrial Strategy introduced the Energy Calculator 2050 (Energy Commission of Nigeria, 2022). The Energy Calculator 2050 is frequently modified by the Energy Commission of Nigeria and the domestic version is known as the Nigeria 2050 Calculator (NECAL2050).

While Nigeria has received support from external organisations, the country prefers to strengthen local capacity rather than outsource relevant skills.

In the same context, the Energy Commission has identified the development of local databases as a goal. To maintain continuity in the energy planning tasks, senior experts train younger staff to retain skill sets within the team.

1.8 SOUTH AFRICA

Disclaimer: The information below is based on the presentation from the Council of Scientific and Industrial Research (CSIR), which is part of the Department of Science and Innovation of South Africa. The CSIR presentation articulates their perspective on how the Integrated Resource Plan (IRP) should be implemented, rather than its implementation in practice.

Institution responsible for long-term energy planning	Department of Mineral Resources and Energy
Most recent official energy planning document	• Integrated Resource Plan (IRP 2019) (Department of Mineral Resources and Energy of South Africa, 2019) • Integrated Energy Plan (IEP 2016) (Department of Mineral Resources and Energy of South Africa, 2016)
Good practices for developing scenarios and planning	• Consultation with different sectors to build trust around the Integrated Resource Plan • Continuous feedback to revise modelling inputs and scenarios assumptions • Assessment of implications of new technology deployment • Participation of system operators to ensure the feasibility of power system plans

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

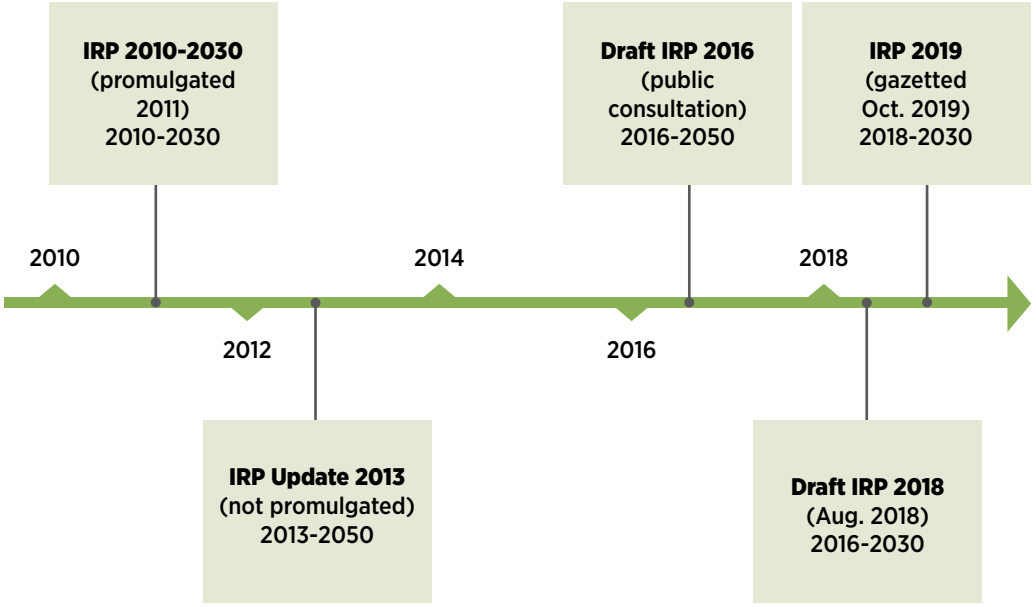
South Africa develops an integrated resource plan (IRP) through extensive consultation with a wide range of parties

The Department of Mineral Resources and Energy of South Africa is responsible for formulating national energy policy based on scenarios assessment. One of its responsibilities is the development of South Africa's IRP. This plan is so far only focused on the power sector because its decarbonisation is more feasible in the mid-term. However, South Africa is working on an integrated energy plan that will include the non-powered energy subsectors.

The Council of Scientific and Industrial Research (CSIR), which is part of the Department of Science and Innovation of South Africa, supports the national governance processes by providing perspectives on energy modelling and how IRP implementation should be done. The most recent IRP, published in 2019, contains energy scenarios up to 2030. Figure 17 presents the IRP development from 2010. The CSIR perspective for a good governance structure during the IRP formulation process recommends that scenario modelling be performed regularly and with the participation of different sectors.

To achieve this, extensive consultation with academia, the transmission network, system operators, government and industry should be carried out routinely. This guarantees that stakeholders provide inputs (practical aspects) at different stages of the processes. This participative approach will help to identify errors and address them, but more importantly it will build trust among the stakeholders involved. It enables different sectors to understand how the models were built and accept the outcomes that later translate into national policy.

Figure 17 Evolution of the South African IRP from 2010 to the present



Source: Carter-Brown (2021).

Pillar 1.2 — Strengthening scenario development – expanding the boundaries of scenarios

Modelling iteration allowed the inclusion of new technologies into South Africa's IRP

The formulation process of IRP studies conducted by CSIR included several renewable energy technologies and assessed their role in specific scenarios. These scenarios considered the intermittency of energy sources including solar and wind. Currently, the IRP evaluates the implications of high deployment of variable renewable energy in the transmission and distribution power grids and its integration costs.

According to scenarios up to 2030, variable renewable energy would comprise most of the total electricity generation, while the contribution of coal-fired power plants would decrease.

The country is deploying solar PV, wind and CSP on a large scale. Recently, the role and opportunities of battery energy storage have also been assessed through modelling work and scenarios analysis. The CSIR envisions that this approach will be adopted at the country level.

Pillar 2.1 — Improving scenario use – clarifying the purpose of scenario building

South Africa develops an IRP based on a dual approach that combines modelling and reality

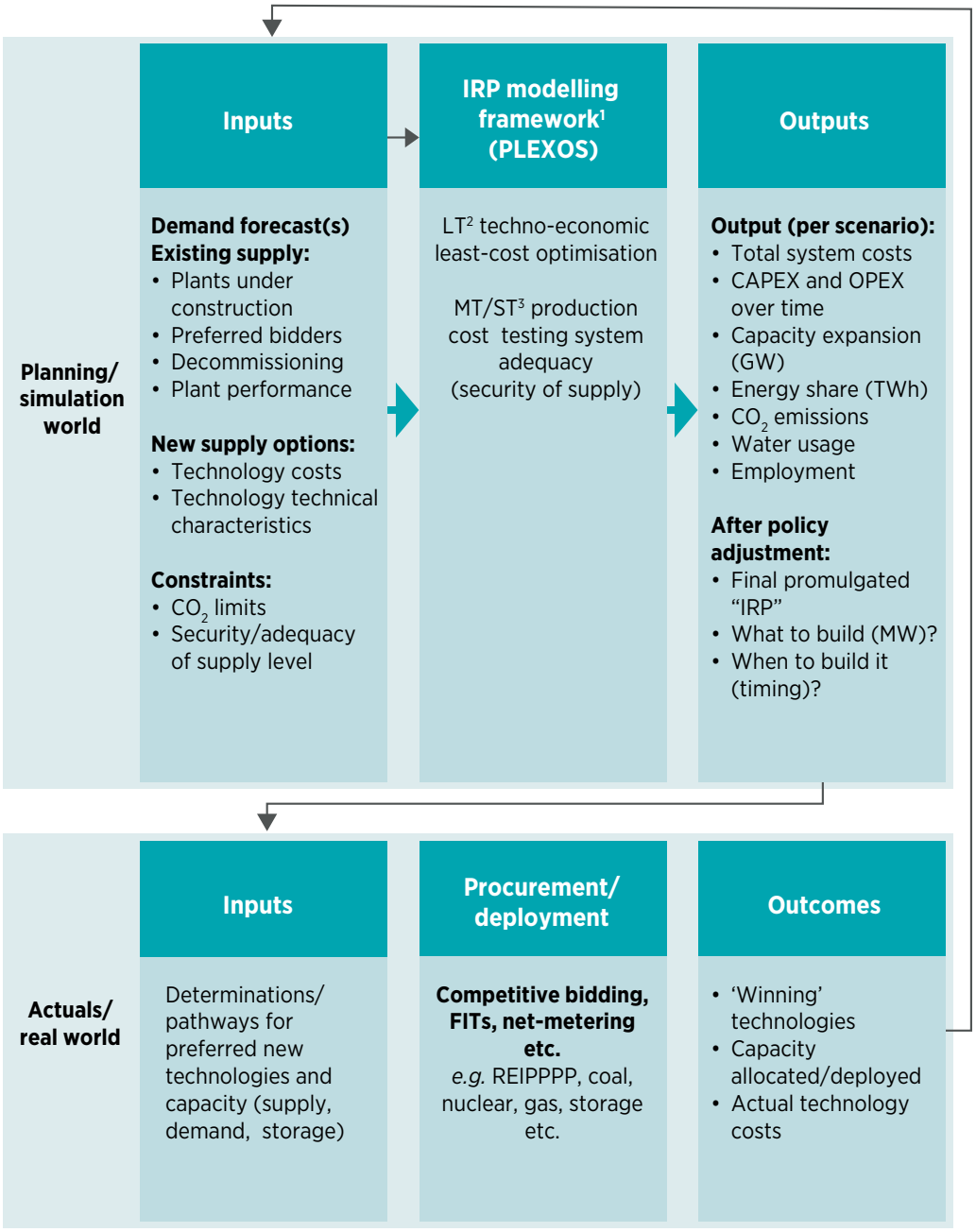
The methodology developed by CSIR for IRP studies uses simulations that are cross checked and improved upon against reality (Figure 18). It can be viewed as a dual world approach:

- The first world comprises planning and simulations, which produce a range of social and environmental outcomes (*e.g.* water consumption, CO_2 emissions, employment opportunities, *etc.*) for different scenarios.

- The second world seeks to understand what the country procures and how to make it possible. The iteration of modelling and outcomes from existing projects would allow for the updating of input data and assumptions in the modelling stage to constantly improve the IRP. However, the framework, software and processes are maintained during iterations.

The outcomes of these two worlds would contribute to policy development. This energy modelling framework is being used at different levels: from national plans to regional plans and down to specific industrial plans.

Figure 18 Overview of the iterative process that led to the South African IRP



Notes: [1] Could include various other commercailly available and/or other open-source tools (South Africa currently opts for PLEXOS). [2] LT = Long-term. [3] MT/ST = Medium-term/Short-term.
Source: Carter-Brown (2021).

Pillar 3.1

Identifying capacity-building approaches – building the right type of scenario capacity in government

South Africa has identified the need for additional capacity building in energy planning

South Africa acknowledges the need to improve capacity building in energy scenarios and energy planning. Having well-trained staff and robust planning tools is a priority for the country. Currently, one of the tools intensively used by the CSIR to plan the expansion and operation of the power system is the PLEXOS commercial software. This software is also used by the Department of Energy.

1.9 TUNISIA

Institution responsible for long-term energy planning	National Agency for Energy Management of Tunisia (ANME)
Most recent official energy planning document	• Nationally Determined Contribution for 2030 (NDC 2030) (République Tunisienne, 2021) • National Low-Carbon Strategy for 2050 (SNBC 2050) (République Tunisienne, 2022)
Good practices for developing scenarios and planning	• Energy scenarios aligned with socio-economic pathways to reach climate change mitigation goals • Consultation and consensus building with different specialised stakeholders • Inclusion of agriculture and transport sectors in the energy strategy • Collaboration with international partners at the global and regional levels for strengthening energy scenarios development and energy planning capacities

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

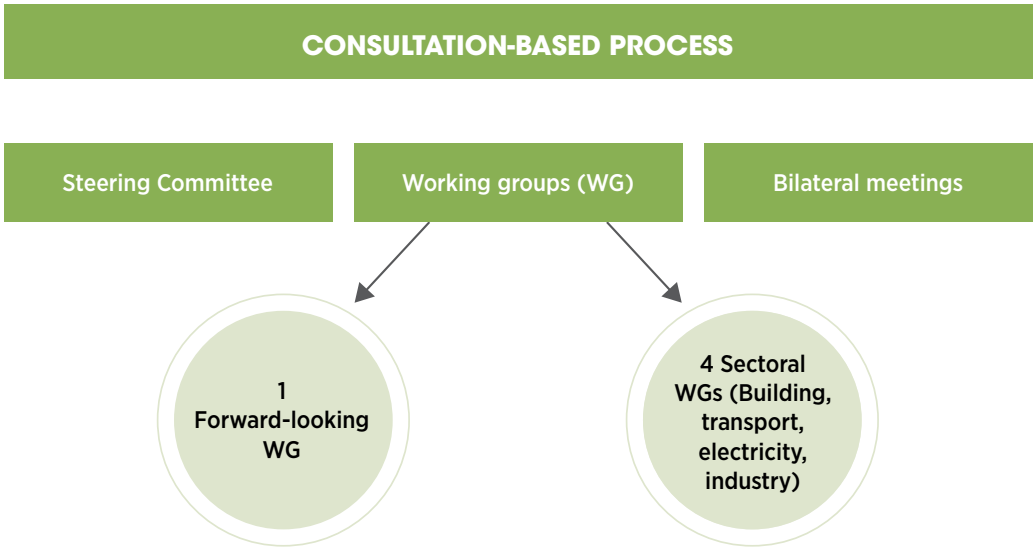
Energy planning in Tunisia is guided by its NDCs and the National Low Carbon Strategy (SNBC)

The National Agency for Energy Management of Tunisia develops the required policies and strategies that will lead the country through a sustainable energy transition. In line with the 2015 Paris Agreement, in 2018, the National Agency for Energy Management of Tunisia (ANME), in collaboration with the Ministry of Local Affairs and Environment and the Ministry of Industry, Energy and Mines, started updating the energy component of the NDC for 2030 (NDC 2030) and preparing the National Low-Carbon Strategy for 2050 (SNBC 2050). Figure 19 illustrates the co-ordination between different sectors during the consultation process.

- The Steering Committee, formed by institutional stakeholders, provides guidance to the working groups specialised in households, transportation, industry and power sectors. These groups developed and analysed various sustainable energy transition scenarios.

- Periodic bilateral meetings with key stakeholders such as the National Energy Observatory and the National Agency for Statistics were held during the process.

Figure 19 Consultation process during the Tunisian NDC 2030 update and the SNBC 2050 development



Source: Elagrebi (2021).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

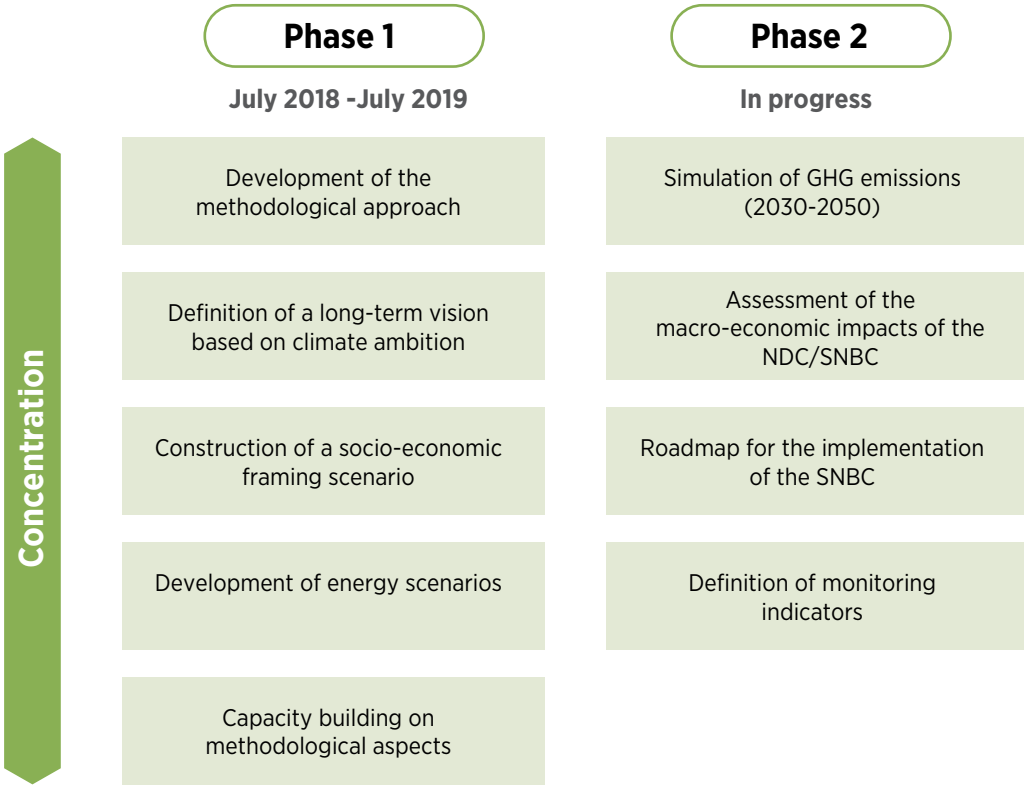
The energy scenarios in Tunisia consider economic and social criteria. Energy scenarios are aligned with the long-term goals enacted by NDC 2030 and SNBC 2050

The energy scenarios in Tunisia are constructed in line with socio-economic scenarios in a two-phase process, as illustrated in Figure 20. These are aligned with the ambitions set in the NDC 2030 and the SNBC 2050. Different scenarios were simulated to analyse the evolution of GHG emissions and the macroeconomic impacts associated with the fulfilment of the goals set to the energy sector in the NDC and SNBC.

The scenarios contemplate upscaling the electricity production from renewable energy sources to reduce GHG emissions while increasing economic growth and local employment. To reach these goals, Tunisia is developing more integrated energy planning scenarios that include the transportation and agriculture sectors.

The strategy contemplates investment in the agricultural sector for the deployment of mini power grids and replacement of traditional energy carriers used in agriculture by modern renewable energies. In addition, Tunisia has defined a strategic policy to foster electrical mobility. Currently, the country is preparing a roadmap for the SNBC implementation and the definition of indicators for monitoring this process.

Figure 20 Assessment and monitoring of the energy component of the Tunisian NDC 2030 and SNBC 2050



Source: Elagrebi (2021).

Pillar 3.1

Identifying capacity-building approaches – building the right type of scenario capacity in government

Tunisia seeks to strengthen its energy planning capacity by training local stakeholders in the use of planning tools and scenarios development. Collaboration with international partners at the regional and global scale is part of the strategy to enhance capacity building

Capacity building in energy planning tools and scenario development is a priority in Tunisia:

- Currently, the GHG emissions simulation is performed with the ENEr-Med model, while the macroeconomic impact associated with measures in the energy sector is assessed through the Multi-sector Macroeconomic Model for the Evaluation of Environmental and Energy policy (ThreeME) model. The ENEr-Med model is a demand forecasting model used to assess impact of various energy efficiency policies nationally as well as the impact on end-uses. These models are developed and designed in collaboration with international partners.

- To reinforce the capacities of the local stakeholders working in energy planning, the country delivers training sessions to develop some of the required skills (statistics, data gathering and economic indicators).

- Tunisia also collaborates at a regional level in a programme with Northern African countries such as Morocco and Algeria. This programme allows for comparison and sharing of best practices in energy planning between countries.

2. LTES EXPERIENCES FROM THE AFRICAN REGIONAL POWER POOLS AND REGIONAL ORGANISATIONS

GENERAL DESCRIPTION

The first part of the webinar series "Long-term energy scenarios (LTES) for Developing National Energy Transition Plans in Africa" (IRENA, 2022a) comprised the sharing of experiences of the participating African countries in the development and use of LTES for planning a clean energy transition in Africa. The series complemented the country level experiences with best practices in the use of LTES to enhance regional energy co-operation and promote regional power markets in Africa. In the last part of the webinar series, the Eastern African Power Pool (EAPP), the West African Power Pool (WAPP) and the Mediterranean Transmission System Operator (Med-TSO) contributed their knowledge of and perspectives about the use of LTES.

Power pools were established on the African continent as a cost-effective way of connecting the excess electricity generation in one country or region with the demand in another. The creation of the regional power pools responds to a need for improved electricity generation capacity and transmission infrastructure within African countries (Medinilla, Byiers and Karaki, 2019).

The EAPP co-ordinates cross-border power trade and grid interconnection among nations in the Eastern Africa region (EAPP, 2021). The EAPP currently has 11 member countries: Burundi, Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan, United Republic of Tanzania, and Uganda (EAPP, 2021). Meanwhile, the WAPP promotes the trade of electricity in Western Africa under the auspices of the Economic Community of West African States (ECOWAS). The member countries of the WAPP are Benin, Burkina Faso, The Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo (WAPP, 2022).

The Med-TSO complemented the regional power pool experiences by presenting its perspectives as a platform for multilateral co-operation in the creation of a Mediterranean energy market that integrates European and African power system operators. This organisation is composed of 20 Mediterranean countries: Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Libya, Montenegro, Morocco, Palestine, Portugal, Slovenia, Spain, Tunisia and Türkiye (Med-TSO, 2022).

This part of the webinar series was aimed at identifying and sharing best practices in the use of LTES by regional power pools to support the development of the African Continental Power System Master Plan (CMP). The CMP is an ongoing initiative led by the African Union

Development Agency (AUDA-NEPAD) that aims to establish a long-term, continent-wide planning process for power generation and transmission involving all African power pools. The goal of the CMP is to promote access to affordable, reliable and sustainable electricity supplies across the African continent (IRENA, 2022c).

The series presents the learnings from the regional power pools concerning the development of the CMP. The crucial role of co-operation between all African power pools, the need to strengthen local capacity in energy planning in Africa, and the establishment of a simplified but solid organisational structure at the regional and continental levels, among other takeaway messages, were discussed.

The summary of each presentation from the African power pools and the Med-TSO is displayed below in three pillars (Figure 1).

2.1 EASTERN AFRICAN POWER POOL (EAPP)

Institution responsible for long-term energy planning	EAPP Planning Committee EAPP Technical Committee
Most recent official energy planning document	• Eastern African Power Pool Master Plan (EAPP Master Plan 2014) (EAPP, 2014)
Good practices for developing scenarios and planning	• Bottom-up approach in which each country develops a national master plan that is included in the regional master plan • Scenarios account for the impacts of energy generation, and operational readiness • Co-ordination with relevant actors during development of the master plan • LTES are discussed and agreed upon by all actors involved • Transparency in the communication of energy scenarios' results • Capacity building through continuous training in collaboration with consultants

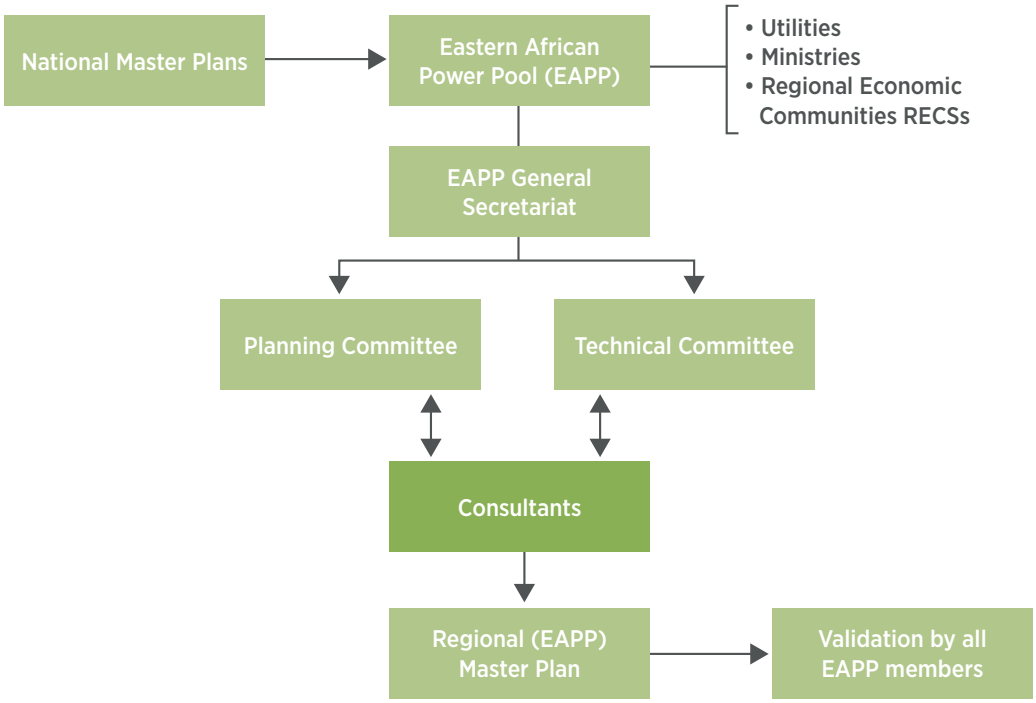
Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

The development of energy scenarios by the EAPP is a collaborative process between representatives from utilities and ministries from member states and regional organisations

The EAPP is a regional institution established in 2005 to co-ordinate cross-border power trade and grid interconnection among nations of the Eastern Africa region (EAPP, 2021). Since the establishment of the EAPP, two energy master plans have been developed, the first in 2011. The second master plan, launched in 2014, was created through a collaborative arrangement in which the EAPP General Secretariat, EAPP member utilities, the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA) and consultants worked together. The development of LTES in the EAPP is led by the Planning Committee and the Technical Committee. During this process different partners, including utilities, ministries and Regional Economic Communities (RECs; EAC and COMESA), from the EAPP member countries are involved. As illustrated in Figure 21, the approach used

by the EAPP in the development of energy scenarios is bottom-up. First, master plans are built at the national level, and then these plans are included in the regional master plan. At present, the EAPP does not have a specific team that develops scenarios. However, the establishment of this team is anticipated as part of the next master plan.

Figure 21 Governance structure of the development of the EAPP Master Plan



Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

The scope of energy scenarios for the EAPP is defined in the terms of reference of the regional master plan as agreed upon by all members

The scope of the LTES developed by the EAPP is defined in the terms of reference of the EAPP Master Plan. The terms of reference are validated and agreed by all members. To foster a sustainable energy transition, LTES always include clean energy transition features. For example, the next master plan considers the development of 1) spatial mapping of generation and transmission resources throughout the EAPP region and 2) the benchmark scenario and planning studies based on independent country generation and transmission plans.

Pillar 2.2 Improving scenario use – transparent and effective communication

The purpose of assessing energy scenarios in the EAPP is to identify the best options for the regional power pool, including infrastructure development

Energy scenarios are developed within EAPP to analyse the impacts of energy generation sources – existing and planned – on the infrastructure development priorities in the Master Plan and on the operational readiness requirements of the power pool. This allows planners to compare all the scenarios and identify the best option for the regional power pool. To ensure transparency during the development of the LTES, the members of the EAPP Planning Technical Committee and RECs (EAC and COMESA) validate scenario results during workshops. Results are published on EAPP platforms after validation.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

The EAPP General Secretariat promotes continuous training, internally and externally from consultants, for its members as part of its activities

To reinforce capacities in energy planning, the EAPP General Secretariat prepares training sessions for EAPP members annually. Capacity building is always incorporated in the EAPP Short-Term Action Plan (three years), which is implemented every year. When the EAPP engages consultants, one of the standalone deliverables is the provision of training to EAPP members.

2.2 WEST AFRICAN POWER POOL (WAPP)

Institution responsible for long-term energy planning	WAPP Strategic Planning and Environment Committee
Most recent official energy planning document	• ECOWAS Master Plan for the Development of Regional Power Generation and Transmission Infrastructure 2019-2033 (Tractebel Engineering S.A., 2018)
Good practices for developing scenarios and planning	• Bottom-up approach for the development of the regional master plan • Establishment of a governance structure with representation from all members • Frequent update of the regional plan to consider the development of new technologies and penetration of renewable energies • Validation of regional master plan by technical experts from all members and then sent for approval

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

The WAPP has established a governing structure that promotes the participation of all members' utilities at the technical and management levels

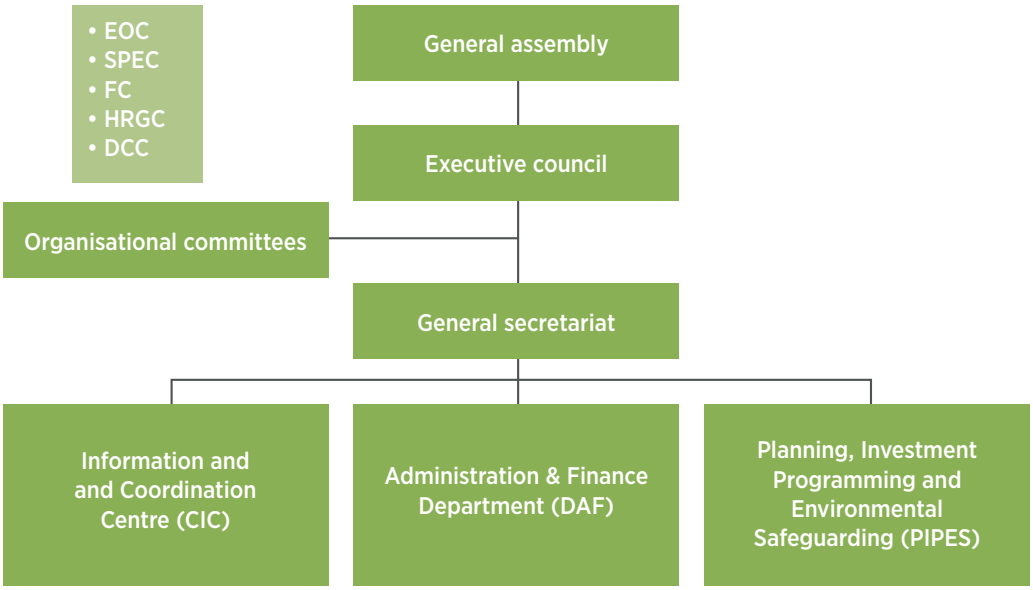
The WAPP is a specialised agency of the ECOWAS. Currently the WAPP has 36 members. Its role is to develop regional electricity infrastructure to integrate the national systems into regional markets. As illustrated in Figure 22, the WAPP comprises four governing structures.

- The General Assembly is composed of all the members' utilities. The decisions made by the General Assembly are implemented by the Executive Board.
- The Executive Board receives advice from the Organisational Committees, which are made up of experts in policy, energy planning and environmental aspects.

- The General Secretariat is the administrative organ of the WAPP, which deals with the daily management of the system.

The current regional master plan was approved in 2018. It was built with a bottom-up approach, in which the energy plans from member states were the starting point toward the regional plan. This master plan was validated by the Strategic Planning and Environment Committee, endorsed by the Executive Board and then sent to the General Assembly for its approval. Thereafter, the plan was presented in a summit where all the head of states from the region agreed upon the plan.

Figure 22 Organisational structure of the WAPP



Notes: EOC = Engineering and Operations Committee. SPEC = Strategic Planning and Environment Committee. FC = Finance Committee. HRGC = Human Resource and Governance Committee. DCC = Distribution and Commercial Committee.
Source: Hessou (2022).

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

The WAPP Regional Master Plan is updated frequently to account for changing factors such as the development of renewable energies, new technologies and strategies at the country level

The current master plan for the ECOWAS region contains strategies for the development of the power sector up to 2022. This regional master plan is updated consistently to consider: 1) changes observed in the strategies of various countries; 2) new national objectives driven by the global energy transition process; 3) the penetration of renewable energies and new

initiatives in the sub-regions; and 4) the development of new technologies. Changes are first incorporated in the national energy master plans and later at a regional level.

Pillar 2.1 Improving scenario use – clarifying the purpose of scenario building

Energy scenarios are used to foster technical discussions at the country level and as tools to reach consensus among WAPP members

Energy scenarios within the ECOWAS are used to promote technical discussions at the country level to ensure that decisions and targets set at the national level are in line with the regional strategy. Technicians, ministries of the countries (ministries of energy) and utilities participate in these discussions. These technical discussions allow for a consensus among member countries, ensuring all members agree on the strategy and policies that will be adopted in the region. The main goals of the regional master plan are to: 1) promote the integration of the variable renewable energy resources in West Africa; 2) guide the development of infrastructure (transmission and generation); and 3) guarantee the security of the energy supply at a competitive cost (Tractebel Engineering S.A., 2018).

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

WAPP members work with consultants and collaborate with other ECOWAS agencies to reinforce capacities in energy planning

At present, WAPP has some in-house expertise in energy planning. However, the secretariat works with consultants to complement the areas outside their capability. To enhance capacity building, consultancy agreements stipulate that consultants must work together with the WAPP members to collect information about national master plans. In addition, the WAPP collaborates with other agencies of the ECOWAS for knowledge and lesson sharing, skills transfer, and capacity reinforcement (Tractebel Engineering S.A., 2018). One of WAPP's ambitions is to have its master plan developed in-house. To achieve this, the WAPP is consistently training the General Secretariat and WAPP members (utilities, companies and ministries). This will allow staff to take part in technical discussions and contribute to master plan development.

2.3 MEDITERRANEAN TRANSMISSION SYSTEM OPERATORS (MED-TSO)

Institution responsible for long-term energy planning	Med-TSO Technical Committee Economic Studies and Scenarios Med-TSO Technical Committee Planning
Most recent official energy planning document	• Mediterranean Network Development Plan at 2030 (Med-TSO, 2018)
Good practices for developing scenarios and planning	• Collaborative governing structure for the development of scenario guidelines and power system modelling • Bottom-up approach for data collection • Development of a dedicated website containing relevant information • Creation of a database for the region containing physical data for modelling • Participation of member states in the validation of scenarios to ensure harmony and coherency in the regional scenario

Pillar 1.1 Strengthening scenario development – establishing a strong governance structure

The development of the Mediterranean Network Development Plan is co-ordinated by two Med-TSO technical committees

The Med-TSO is an international co-operation platform grouping together transmission system operators from the Mediterranean region. Med-TSO aims to enhance the integration of the Mediterranean transmission power system by optimising the use of existing interconnections and promoting the development of new interconnections. Med-TSO is responsible for the preparation of the Mediterranean Power Plans with financial aid from the European Commission.

The most recent Mediterranean Network Development Plan (MNDP) was developed in the period 2018-2020. Med-TSO is structured into five technical committees. The MNDP is developed through the co-ordination of two of them: the Technical Committee Economic

Studies and Scenarios (TC-ESS), which is responsible for developing the scenarios and for performing the market studies, and the Technical Committee Planning (TC-P), which performs grid studies (*e.g.* infrastructure planning criteria, assembling national development plans, *etc.*).

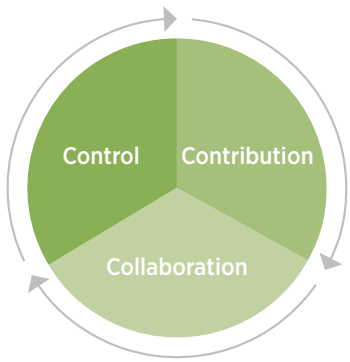
Med-TSO develops energy scenarios with a bottom-up approach in which member states are responsible for collecting data at the national level, and then the TC-ESS uses this data for modelling. When the model is finished, it is validated by member states through a two-phase validation process.

Pillar 1.2 Strengthening scenario development – expanding the boundaries of scenarios

The energy scenarios developed by Med-TSO contemplate the benefits of new technologies, economic opportunities and CO_2 emissions, among other features

The development of energy scenarios carried out by Med-TSO is based on the CCC approach (collaboration, contribution and control), as illustrated in Figure 23. Under a collaborative process, the TC-ESS together with TC-P defines the scenario-building methodology, including the scope of analysis. This is done through several workshops with relevant stakeholders in which the common scenario definition, storyline and common assumptions (*e.g.* fuel price, CO_2 emissions, plant efficiency) are specified. These scenarios explore different aspects associated with the power sector and the development of new interconnections among Mediterranean countries, such as economic opportunities, excesses of energy (*e.g.* surplus of renewable energy), the efficiency of new technologies versus traditional ones, seasonal variations in consumption and generation, and the effect of consumption peaks along the different time zones in the region. To support modelling, Med-TSO provides access to a database to its members. This database contains regional information about temperature, irradiation for solar and wind, and other physical parameters crucial for modelling.

Figure 23 Scenario-building approach used by Med-TSO



Source: Bué (2022).

Pillar 2.2 Improving scenario use – transparent and effective communication

Med-TSO uses energy scenarios to explore opportunities for energy exchange and investment in the Mediterranean region

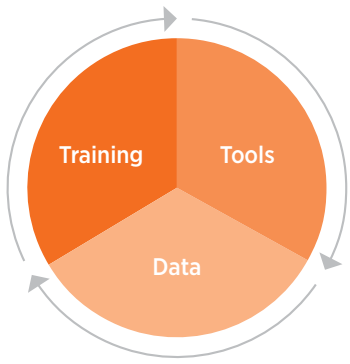
The assessment of diverse scenarios permits Med-TSO to address the uncertainty associated with long-term energy planning. Developing these scenarios with planning tools at the regional level also supports member countries' exploration of investment in power projects. To communicate the results from energy scenarios, Med-TSO performed a series of webinars in which the Master Plan 2020 was presented to stakeholders. In addition, the organisation created a dedicated website from where the master plan report, the scenario report and full details of the scenario master plan, among other information, can be accessed. The market study models implemented on Antares – open-source software developed by the French transmission system operator RTE – are made available and accessible to every Med-TSO member.

Pillar 3.1 Identifying capacity-building approaches – building the right type of scenario capacity in government

Med-TSO's capacity-building programme for its members is focused on training and the provision of data and tools

Strengthening capacity building in energy planning is one of Med-TSO's priorities. Technical committees provide support to members to gain the skills required to advance the energy transition in the Mediterranean region. Figure 24 presents the three pillars of Med-TSO's capacity-building programme: training, data and tools. Med-TSO organises training sessions directed at member states, provides tools (open-source tools) and enables access to the regional database to facilitate energy scenario modelling.

Figure 24 Pillars of Med-TSO's energy planning capacity-building programme



Source: Bué (2022).

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